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Rev. 0

Remedial Investigation Data Quality Objectives Summary Report for the 200-TW-1 Scavenged Waste Group and 200-TW-2 Tank Waste Group Operable Units

Prepared for the U.S. Department of Energy, Richland Operations Office
Office of Environmental Restoration

Submitted by: Bechtel Hanford, Inc.

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Date Published

June 2000

EXECUTIVE SUMMARY

This data quality objective (DQO) summary report supports site characterization decisions for remedial investigation (RI) at representative waste sites in the 200-TW-1 Scavenged Waste Group Operable Unit (OU) and the 200-TW-2 Tank Waste Group OU. The 200-TW-1 OU consists of 35 *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) past-practice waste sites (consisting mostly of cribs and trenches) and one unplanned release (UPR) site. The 200-TW-2 OU includes 27 *Resource Conservation and Recovery Act of 1976* (RCRA) past-practice waste sites (consisting mostly of cribs, trenches, and reverse wells) and one UPR site. The OU designations and waste site assignments are defined in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (hereinafter referred to as the Implementation Plan) (DOE-RL 1999). Waste sites in the 200-TW-1 and 200-TW-2 OUs received effluent waste streams that contained significant concentrations of chemicals and radionuclides. Data collected during the RI will be used to determine if the waste sites are contaminated above levels that will require remedial action, to support evaluation of remedial alternatives, and to verify or refine the conceptual contaminant distribution models.

This DQO effort follows the concepts developed in the Implementation Plan (DOE-RL 1999) for using analogous site contaminant data to reduce the amount of characterization required to support remedial investigation/feasibility study (RI/FS) decisions. These concepts involve grouping sites with similar process histories, structures, and contaminants and then choosing one or more representative sites for comprehensive field investigation, including sampling during RI activities. Findings from the RI at representative sites are then used to make remedial action decisions for all the waste sites in the OU. Non-representative sites for which field data have not been (or will not be) collected are assumed to have chemical characteristics similar to the representative sites that are characterized. A Record of Decision for the OU will be obtained through the RI/FS process using the data collected during the RI. The analogous sites (those not sampled during the RI) will be addressed during the confirmatory sampling phase to ensure that the remedial action specified in the Record of Decision is appropriate and to provide design data

as needed. Following remedial actions, verification samples will be collected to support site closeout.

For the 200-TW-1 OU, two representative waste sites have been identified, and in the 200-TW-2 OU, three representative waste sites have been identified. The goals of the RI are to provide the data needed to support remedial decisions and to refine the preliminary conceptual contaminant distribution and exposure models for these OUs. The data will be generated mainly through soil sampling and analysis.

The Washington State Department of Ecology document, *Guidance on Sampling and Data Analysis* (Ecology 1995), was used in developing the sampling design for the RI. Since the data will not be used to demonstrate compliance with a cleanup level, focused (biased) soil sampling of areas selected with the highest contamination potential was selected over an area-wide (unbiased) sample design. The concentrations of all contaminants in each soil sample will be compared directly with the cleanup levels; a statistical analysis of the sampling data is not appropriate for focused sampling schemes and is, therefore, not used in this report. The locations of samples exceeding the cleanup level will be used to delineate the areas of soil contamination requiring a decision on the need for remediation.

The proposed sampling locations were selected with the goal of intersecting the areas of highest contamination and determining the vertical extent of contamination. The nature (e.g., contaminant type and concentration) and the vertical extent of the contamination are the major RI data needs. For representative sites where sufficient data have been collected to support the RI/FS process, additional sampling will not be conducted; however, for these sites, geophysical logging of nearby existing boreholes will be conducted. For sites that have not been adequately characterized, a borehole will be drilled to the groundwater table and soil samples will be collected from the entire length of the borehole. Geophysical logging of planned and existing boreholes will also be performed. For trench site 216-B-38, additional locations within the waste site will be geophysically logged through direct-push or cased holes.

Executive Summary

The contaminants of potential concern were identified through process history information and previous data collection efforts. Analytical performance criteria were based on *Model Toxics Control Act* chemical compliance criteria (*Washington Administrative Code* 173-340) and other applicable or relevant and appropriate requirements. In the absence of applicable or relevant and appropriate requirements, other preliminary action levels were identified to determine analytical performance criteria. These levels provide the basis for identifying the laboratory or field screening detection limits required to support remedial action decisions. A modified version of the U.S. Environmental Protection Agency's DQO guidance (EPA 1994) was used to identify project data quality needs, evaluate sampling and analysis options, and document project data quality decisions.

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ACRONYMS

AEA	alpha energy analysis
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BHI	Bechtel Hanford, Inc.
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CHI	CH2M Hill Hanford, Inc.
COC	contaminant of concern
COPC	contaminant of potential concern
CPP	CERCLA past-practice
CVAA	cold vapor atomic absorption
DOE	U.S. Department of Energy
DQO	data quality objective
DR	decision rule
DS	decision statement
Ecology	Washington State Department of Ecology
EMI	electromagnetic imaging
EPA	U.S. Environmental Protection Agency
FS	feasibility study
GC	gas chromatograph
GCMS	gas chromatography/mass spectrometry
GEA	gamma energy analysis
GPC	gas proportional counter
GPR	ground-penetrating radar
HEIS	Hanford Environmental Information System
HPGe	high-purity germanium
IC	ion chromatography
ICP	inductively coupled plasma
ICPMS	inductively coupled plasma mass spectrometer
IDW	investigation-derived waste
MCL	maximum contamination level
MTCA	*Model Toxics Control Act*
NaI	sodium iodide
OU	operable unit
PCB	polychlorinated biphenyl
PQL	practical quantitation limit
PRG	preliminary remediation goal
PSQ	principal study question
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR/RAWP	remedial design report/remedial action work plan

Acronyms

RESRAD	RESidual RADioactivity dose model
RFI	*Resource Conservation and Recovery Act* field investigation
RI	remedial investigation
RL	U.S. Department of Energy, Richland Operations Office
ROD	Record of Decision
RPP	*Resource Conservation and Recovery Act of 1976* past-practice
SAP	sampling and analysis plan
SGL	spectral gamma logging
SVOC	semi-volatile organic compound
TBP	tributyl phosphate
TOC	total organic carbon
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU (waste)	waste materials contaminated with 100 nCi/g of transuranic materials having half-lives longer than 20 years
TSD	treatment, storage, and disposal
UCL	upper confidence limit
UPR	unplanned release
URP	uranium recovery process
VOA	volatile organic analysis
WAC	*Washington Administrative Code*
WDOH	Washington State Department of Health
WIDS	Waste Information Data System

METRIC CONVERSION CHART

Into Metric Units

If You Know	*Multiply By*	*To Get*
Length		
inches	25.4	Millimeters
inches	2.54	Centimeters
feet	0.305	Meters
yards	0.914	Meters
miles	1.609	Kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.093	sq. meters
sq. yards	0.0836	sq. meters
sq. miles	2.6	sq. kilometers
acres	0.405	Hectares
Mass (weight)		
ounces	28.35	Grams
pounds	0.454	Kilograms
ton	0.907	Metric ton
Volume		
teaspoons	5	Milliliters
tablespoons	15	Milliliters
fluid ounces	30	Milliliters
cups	0.24	Liters
pints	0.47	Liters
quarts	0.95	Liters
gallons	3.8	Liters
cubic feet	0.028	Cubic meters
cubic yards	0.765	Cubic meters
Temperature		
Fahrenheit	Subtract 32, then multiply by 5/9	Celsius
Radioactivity		
picocuries	37	Millibecquerel

Out of Metric Units

If You Know	*Multiply By*	*To Get*
Length		
Millimeters	0.039	inches
Centimeters	0.394	inches
Meters	3.281	feet
Meters	1.094	yards
Kilometers	0.621	miles
Area		
sq. centimeters	0.155	sq. inches
sq. meters	10.76	sq. feet
sq. meters	1.196	sq. yards
sq. kilometers	0.4	sq. miles
Hectares	2.47	acres
Mass (weight)		
Grams	0.035	ounces
Kilograms	2.205	pounds
Metric ton	1.102	ton
Volume		
Milliliters	0.033	fluid ounces
Liters	2.1	pints
Liters	1.057	quarts
Liters	0.264	gallons
Cubic meters	35.315	cubic feet
Cubic meters	1.308	cubic yards
Temperature		
Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity		
Millibecquerel	0.027	picocuries

1.0 STEP 1 -- STATE THE PROBLEM

The purpose of data quality objective (DQO) Step 1 is to clearly and concisely state the problem to ensure that the focus of the study will be unambiguous.

1.1 INTRODUCTION

This summary report has been developed to support the remedial investigation/feasibility study (RI/FS) and remedial action decision-making processes for the 200-TW-1 and 200-TW-2 Operable Units (OUs). The 200-TW-1 OU is being remediated under a *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) approach. The 200-TW-1 OU consists of 35 waste sites (consisting mostly of cribs and trenches) and one unplanned release (UPR) site. Two representative sites have been identified for the 200-TW-1 OU in the *Waste Site Grouping for 200 Area Soil Investigations* report (DOE-RL 1997) and the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (hereinafter referred to as the Implementation Plan) (DOE-RL 1999). The 200-TW-2 OU is being addressed under the *Resource Conservation and Recovery Act of 1976* (RCRA). The 200-TW-2 OU includes 27 waste sites (consisting mostly of cribs, trenches, and reverse wells) and one UPR site. Three of the 200-TW-2 sites have been selected as representative sites.

This DQO summary report focuses on the development of sampling designs for the representative (typical and worst-case) sites identified in the waste site grouping report (DOE-RL 1997) and the Implementation Plan (DOE-RL 1999). Representative waste sites chosen for the 200-TW-1 OU include the 216-B-46 Crib and the 216-T-26 Crib. The 200-TW-2 OU representative waste sites are the 216-B-5 reverse well, 216-B-7A and 216-B-7B Cribs, and 216-B-38 Trench.

The 216-B-46 Crib and 216-T-26 Crib are typical waste sites for the 200-TW-1 OU. Waste sites in this OU received very similar types and amounts of contaminants. No one particular site stands out as a worst-case site for this OU. The 216-B-5 reverse well and 216-B-7A&B Cribs are worst-case sites for the 200-TW-2 OU. These sites received significantly higher inventories of waste, and in the case of the reverse well, contaminants were released directly into the groundwater. The 216-B-38 Trench is a typical waste site for the OU.

The Washington State Department of Ecology (Ecology) document, *Guidance on Sampling and Data Analysis* (Ecology 1995), was used during this DQO to support the selection of an appropriate sampling approach. Table 1 of the Ecology guidance summarizes approaches for sampling and data analysis considered acceptable to Ecology. This guidance shows that a focused sampling approach may be used to investigate a site that is known to be contaminated and contaminated regions may be identified for sampling and analysis.

The waste sites in the 200-TW-1 OU received predominantly waste effluent from the uranium recovery and ferrocyanide scavenging processes associated with B and T Plant wastes. These

processes were performed in U Plant or within the tank farms, and the waste was disposed to the vadose zone through the cribs and trenches. The waste sites in the 200-TW-2 OU received predominantly waste effluent from the bismuth-phosphate process used at B and T Plants to separate plutonium from other radionuclides. This waste was routed through the tank farms at these plants and was ultimately disposed to the vadose zone through the cribs and trenches.

A map of the Hanford Site is provided in Figure 1-1 and depicts the 200 Areas and vicinity (i.e., the location of the 200-TW-1 and 200-TW-2 OUs). Figures 1-2 through 1-4 identify the locations of the 200-TW-1 and 200-TW-2 OU waste sites and the associated source facilities.

1.2 PROJECT SCOPE

This DQO summary report focuses on the representative waste sites associated with the 200-TW-1 Scavenged Waste Group OU and the 200-TW-2 Tank Waste Group OU. The scope of this project includes the DQO process and development of a sampling and analysis plan (SAP) for the five representative sites. The DQO summary report and SAP will provide the basis for the RI for the 200-TW-1 sites and the RCRA facility investigation (RFI) for the 200-TW-2 sites. The process for integrating CERCLA past-practice (CPP) and RCRA past-practice (RPP) sites is defined in the Implementation Plan (DOE-RL 1999). The Implementation Plan presents a consistent approach to data collection activities associated with 200 Area assessment and remediation activities. The activities include all phases of sampling required to support the completion of the integrated RCRA/CERCLA process outlined in Section 2.3 and depicted in Figure 2-2 of the Implementation Plan (DOE-RL 1999). Specific activities include the following:

- Data collection at representative sites defined for the waste group-specific OU work plan, with an emphasis on verifying the conceptual model. This will support preparation of a focused feasibility study and remedial action decision making.

- Data collection after the Record of Decision (ROD) to confirm that all other sites in the specific waste group OU meet the conceptual model. In addition, data collection activities will be included as part of the remedy selected for the waste group and will provide site-specific information for preparation of the remedial design report/remedial action work plan (RDR/RAWP).

- Data collection, as defined in the RDR/RAWP, to verify that remedial actions associated with a remove, treat, and dispose remedy have met the required objectives.

- Data collection defined as part of the post-closure monitoring plan section in a closure plan for a RCRA treatment, storage, and disposal (TSD) unit or RPP site. For CERCLA sites, remedies where waste is left in place and a barrier cover is installed may include an operations and monitoring plan that requires specific monitoring activities to demonstrate adequacy of the design.

Figure 1-1. Location of the Hanford Site and 200-TW-1 and 200-TW-2 Operable Unit Waste Sites.

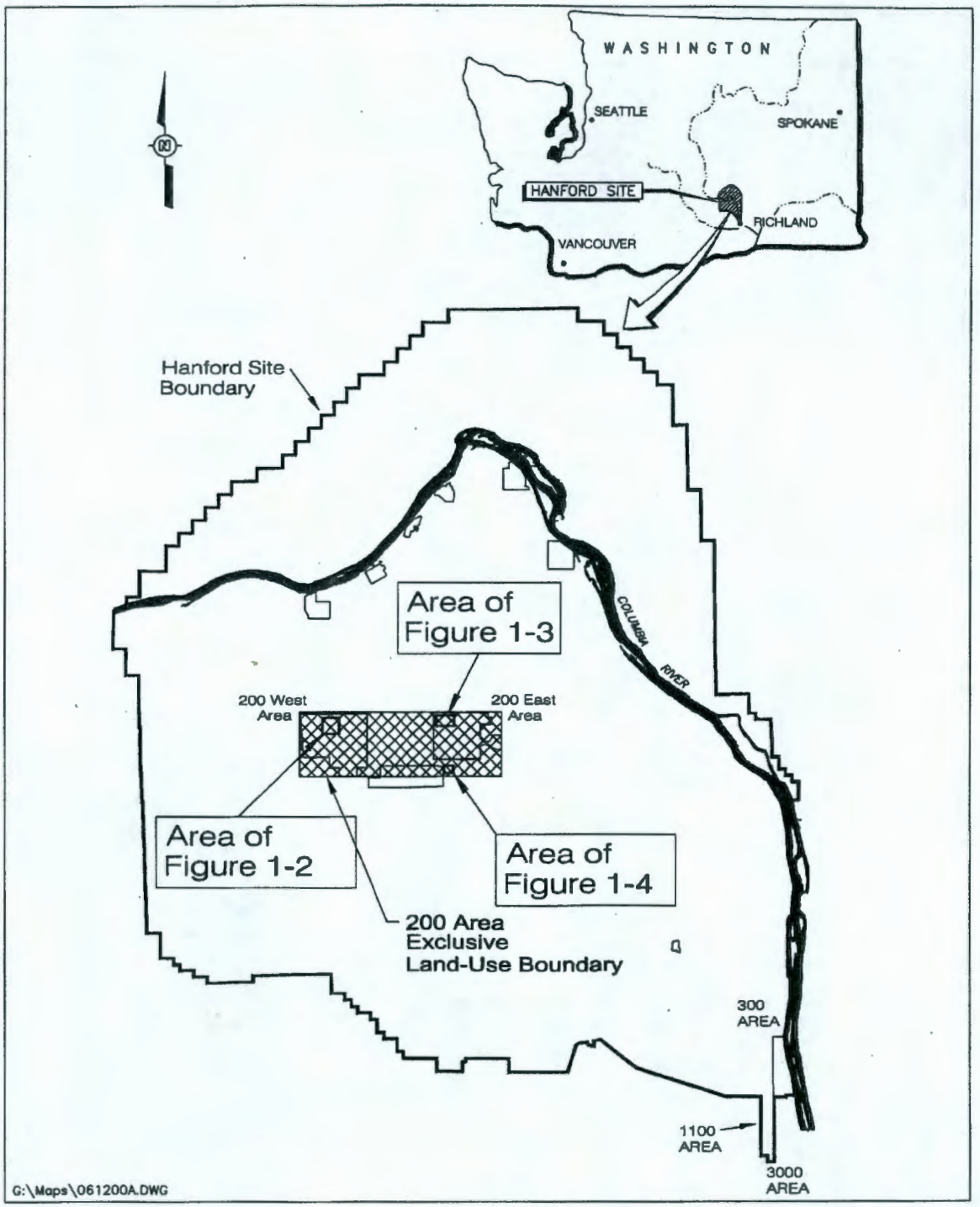
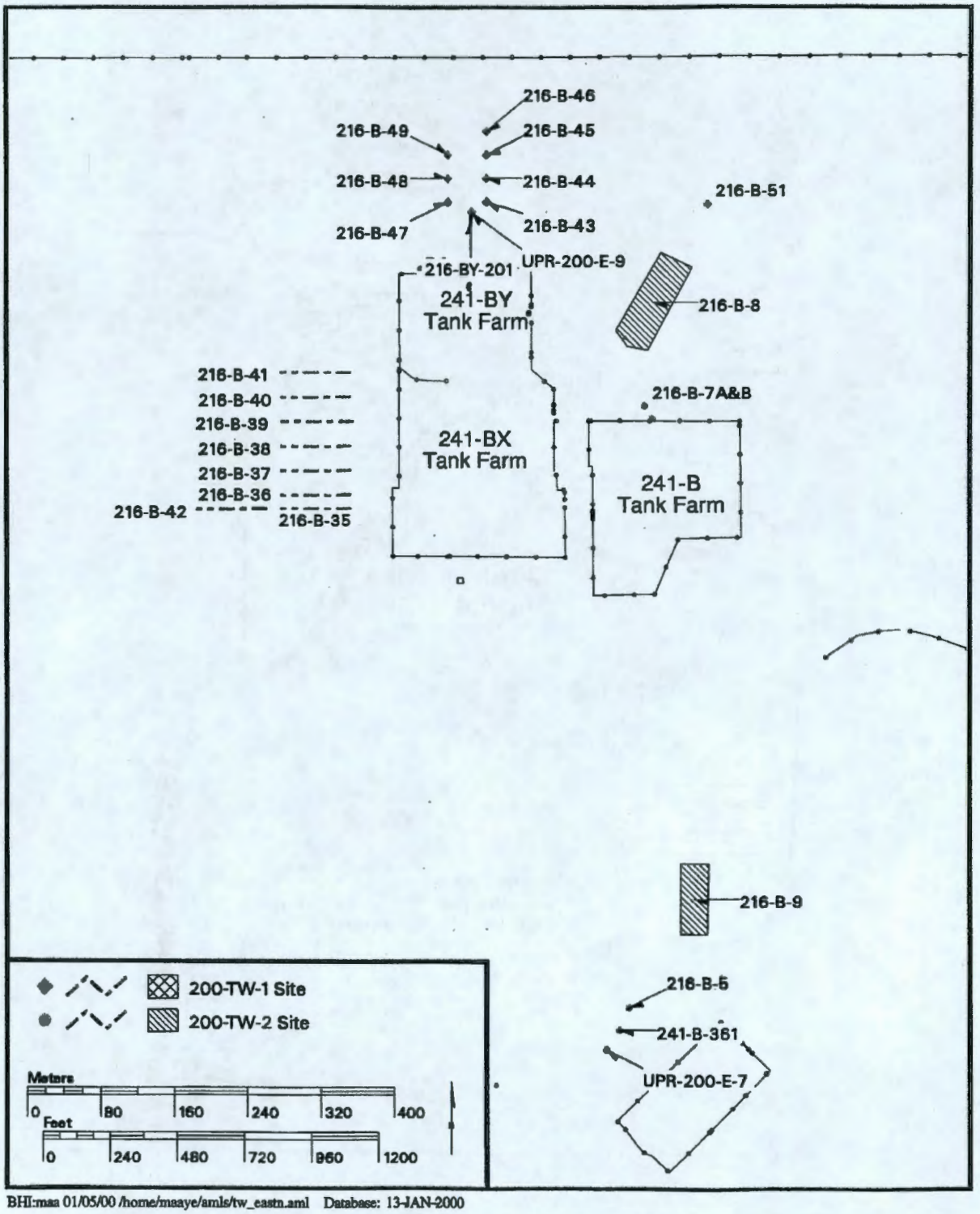
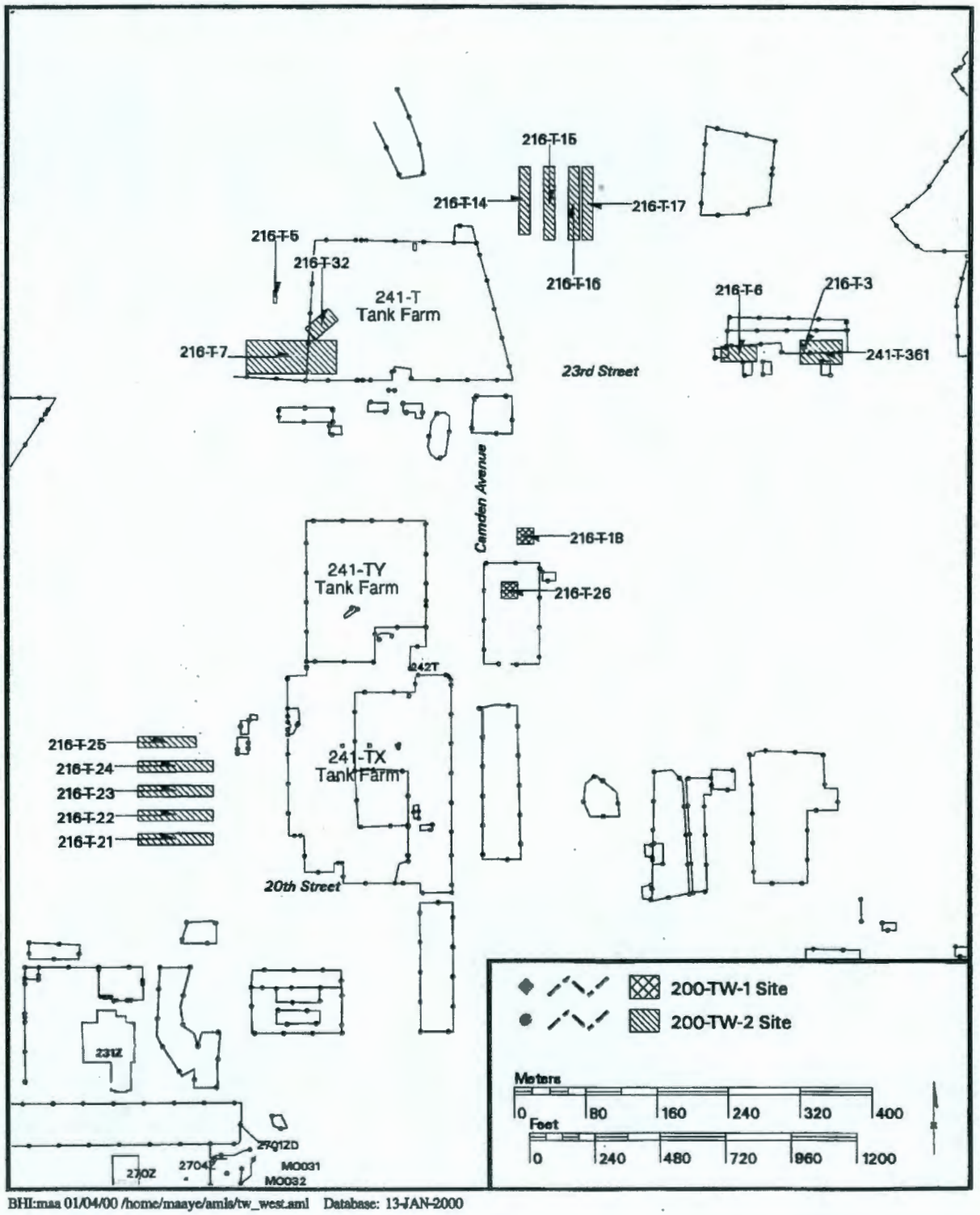


Figure 1-2. 200-TW-1 and 200-TW-2 Operable Unit Waste Sites Located in the 200 East Area.



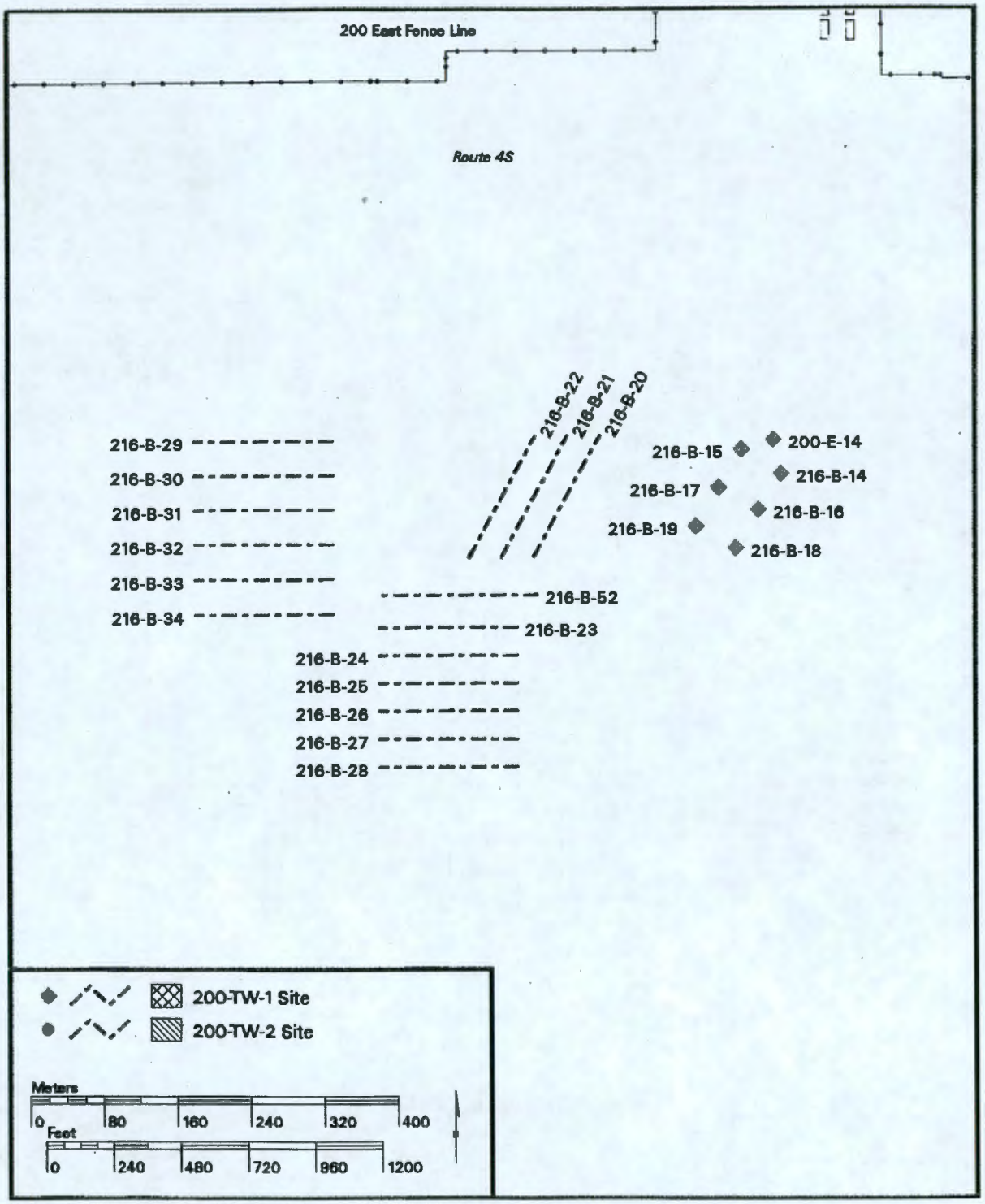
BHI:maa 01/05/00 /home/maaye/amls/tw_eastn.aml Database: 13-JAN-2000

Figure 1-3. 200-TW-1 and 200-TW-2 Operable Unit Waste Sites Located in the 200 West Area.



BHI:maa 01/04/00 /home/maaye/amls/tw_west.aml Database: 13-JAN-2000

Figure 1-4. 200-TW-1 Operable Unit Waste Sites Located South of the 200 East Area.



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This DQO process supports the data collection from the first bullet that will support the evaluation of remedial alternatives and RI/FS decision making. Additional DQO processes will be conducted to define the sampling requirements for the other phases of data collection.

For the 200-TW-1 and 200-TW-2 OUs, a single RI/FS work plan will be prepared that satisfies, in concert with the Implementation Plan (DOE-RL 1999), the requirements for both the RI and the RFI. The data acquired during the RI will support the RI/FS and RFI/corrective measures study processes for these two OUs. For ease of preparation and readability (and as described in the Implementation Plan [DOE-RL 1999]), the RI/FS terminology will be used throughout the DQO summary report and work plan documents.

1.3 PROJECT OBJECTIVES

The objective of the DQO process for the 200-TW-1 Scavenged Waste Group OU and the 200-TW-2 Tank Waste Group OU is to determine the environmental measurements necessary to support the RI/FS process and remedial decision making, including refinement of the preliminary conceptual contaminant distribution model. Additionally, the DQO process supports development of a SAP for the RI, which will be included as an appendix to the RI/FS work plan for the OU.

Possible alternatives identified in the Implementation Plan (DOE-RL 1999) include the following:

- No action alternative (no institutional controls)
- Engineered multimedia barrier
- Excavation and disposal of waste
- Excavation, ex situ treatment, and geologic disposal of transuranic soil
- In situ vitrification of soil
- In situ grouting or stabilization
- Monitored natural attenuation (with institutional controls).

1.4 PROJECT ASSUMPTIONS

Project assumptions for the RI include the following

- The DQO process will follow BHI-EE-01, *Environmental Investigations Procedures*, Procedure 1.2, "Data Quality Objectives," and Section 6.1 of the Implementation Plan (DOE-RL 1999).

- The 200-TW-1 and 200-TW-2 waste groups are source waste groups and the investigations will focus on vadose zone soil contamination.

- The Implementation Plan (DOE-RL 1999) outlines the assessment and remediation approach to be followed for the OU:
  - Defines the regulatory framework
  - Defines the integration of RPP and CPP strategies
  - Generally identifies the characterization approach
  - Provides background information on 200 Area site conditions, operational history, and secondary plans (e.g., quality assurance, health and safety, information management, and waste management)
  - Provides governing assumptions, including preliminary applicable or relevant and appropriate requirements (ARARs), land-use considerations, remedial action objectives, and remedial action alternatives.
- The analogous site approach will be used. Characterization will be limited to representative waste sites and the characterization will be used to reach remedial decisions for all waste sites within the OUs. The DQO effort will focus on representative waste sites within each OU. Preliminary representative waste sites have been selected in the waste site grouping report (DOE-RL 1997) and the Implementation Plan (DOE-RL 1999) that were considered to be representative of typical and worst-case conditions for each OU. Representative waste sites for the 200-TW-1 OU are as follows:
  - 216-B-46 Crib (typical site)
  - 216-T-26 Crib (typical site).

  Specific waste sites and UPRs within the OU are listed in Appendix G of the Implementation Plan (DOE-RL 1999). Sites identified in the 200-TW-1 OU, in addition to the representative sites, are listed below:
  - 216-E-14 storage tank
  - 216-B-14 Crib
  - 216-B-15 Crib
  - 216-B-16 Crib
  - 216-B-17 Crib
  - 216-B-18 Crib
  - 216-B-19 Crib
  - 216-B-20 Trench
  - 216-B-21 Trench
  - 216-B-22 Trench
  - 216-B-23 Trench
  - 216-B-24 Trench
  - 216-B-25 Trench

- 216-B-26 Trench
- 216-B-27 Trench
- 216-B-28 Trench
- 216-B-29 Trench
- 216-B-30 Trench
- 216-B-31 Trench
- 216-B-32 Trench
- 216-B-33 Trench
- 216-B-34 Trench
- 216-B-42 Trench
- 216-B-43 Crib
- 216-B-44 Crib
- 216-B-45 Crib
- 216-B-47 Crib
- 216-B-48 Crib
- 216-B-49 Crib
- 216-B-51 Crib
- 216-B-52 Trench
- 216-BY-201 settling tank
- 216-T-18 Crib
- UPR-200-E-9.

Representative waste sites for the 200-TW-2 OU are as follows:

- 216-B-5 reverse well (second worst-case site)
- 216-B-7A and 216-B-7B Cribs (worst-case site)
- 216-B-38 Trench (typical site).

Sites identified in the 200-TW-2 OU, in addition to the representative sites, are as follows:

- 216-B-8 Crib
- 216-B-9 Crib
- 216-B-35 Trench
- 216-B-36 Trench
- 216-B-37 Trench
- 216-B-39 Trench
- 216-B-40 Trench
- 216-B-41 Trench
- 216-T-3 reverse well
- 216-T-5 Trench
- 216-T-6 Crib
- 216-T-7 Crib
- 216-T-14 Trench

- 216-T-15 Trench
- 216-T-16 Trench
- 216-T-17 Trench
- 216-T-21 Trench
- 216-T-22 Trench
- 216-T-23 Trench
- 216-T-24 Trench
- 216-T-25 Trench
- 216-T-32 Crib
- 241-B-361 settling tank
- 241-T-361 settling tank
- UPR-200-E-7.

Sampling to characterize the non-representative waste sites is not included in the 200-TW-1 and 200-TW-2 work plan scope.

- A review of the representative sites is a key component of the DQO process; the representative sites identified in the waste site grouping report (DOE-RL 1997) and the Implementation Plan (DOE-RL 1999) will be revisited with the DQO scoping team members and key decision makers to ensure that the appropriate sites are chosen. The final selection of representative waste sites is considered flexible (i.e., different waste sites may be selected as representative sites, or additional representative sites may be added) and will consider critical data needs of other Groundwater/Vadose Zone core projects (e.g., the River Protection Project or the Science and Technology Project). Integration of characterization efforts will promote a more efficient and cost-effective use of resources while still obtaining the necessary data to support the objectives for the 200-TW-1 and 200-TW-2 OUs. Active participation by other Groundwater/Vadose Zone core projects will be solicited to provide input to the DQO process.

- Extensive characterization of the 216-B-46 Crib was conducted as part of the 200-BP-1 OU remedial investigation in the early 1990s. The adequacy of the data to support the RI/FS process is evaluated in Section 3.0.

- The 216-B-7A and 216-B-7B Cribs received approximately 43.6 million L (11.5 million gal) of process waste from the 221-B and 224-B facilities from 1946 to 1967. This waste contained 4.3 kg of plutonium and over 4,500 curies of beta/gamma emitters. The 216-B-5 reverse well received approximately 4.3 kg of plutonium. The 216-B-5 reverse well was investigated in 1979 and 1980 for radionuclide contamination. This information may be sufficient for RI/FS decision making concerning radionuclide contamination and will be evaluated in Section 3.0.

- The potential for transuranic radionuclides at concentrations greater than 100 nCi/g exists for sites in these OUs.

- Existing characterization data from waste sites within the OUs and analogous data (i.e., borehole logging results from boreholes in the vicinity of the waste sites) will be used to support the DQO process and to prepare the work plan. Based on historical site uses and current contaminant of potential concern (COPC) information, it is expected that waste site contaminants of concern (COCs) will exceed action levels and that remediation will be required at most sites. However, it is possible that COC action levels will not be exceeded. In this instance, follow-up verification sampling during the confirmatory, design, and verification phases would be conducted to ensure that site closeouts without remediation are adequately supported. These activities would be conducted under separate DQO processes.

- The DQOs will be used to prepare a SAP to be included in the 200-TW-1 and 200-TW-2 RI/FS work plan. These OUs have *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1998) milestones (M-13-23 and M-13-24) for submittal of work plans by August 31, 2000. One work plan will be prepared to cover investigation activities associated with both OUs, which will fulfill the Tri-Party Agreement requirements for both milestones.

- Preliminary conceptual contaminant distribution models for the 200-TW-1 and 200-TW-2 waste groups have been developed in *Waste Site Grouping for 200 Area Soil Investigations* (DOE-RL 1997). These preliminary conceptual contaminant distribution models provide an initial prediction of the nature and extent of the primary COCs. Models for individual representative sites will be developed as part of the DQO effort and work plan preparation.

- Remedial actions will likely be required to achieve ARARs, including soil cleanup standards of the *Model Toxics Control Act* (MTCA) (*Washington Administrative Code* [WAC] 173-340) for chemical contaminants and radiological dose limits to be determined in the future. For purposes of this DQO process, a dose limit of 100 mrem/yr above natural background for radionuclides in soil is assumed as a reasonable, representative range of acceptable dose limits. In accordance with 10 *Code of Federal Regulations* (CFR) 20 and 10 CFR 835, the total effective dose equivalent for members of the public entering a controlled area is 100 mrem/yr. Because the waste sites in these OUs are contained within the exclusive land-use boundary for the 200 Areas, an industrial land-use scenario is assumed.

- Potential data uses that need to be considered when developing DQOs include preliminary conceptual contaminant distribution model refinement; evaluation of remedial action alternatives, remedial action decisions, and risk assessment; and worker health and safety.

- The data collected will support investigation-derived waste (IDW) disposal. The data collected to solve the problem statement will satisfy the designation of the IDW. At this point in time and based on the available information reviewed for this DQO, no listed wastes have been identified for the representative sites or for any of the sites in the OUs. Characteristic wastes will be evaluated based on total analytical results. Toxicity characteristic leaching procedures may be conducted if total results exceed the regulatory standards in WAC 173-303-090.

- Groundwater has been impacted in the past by waste sites in these OUs, and mobile contaminants were disposed at the sites within these waste groups. However, evaluation of groundwater contamination and remediation is not included in the scope of the work plan.

The RI (i.e., initial OU characterization) will validate, or provide the basis to refine, the preliminary conceptual contaminant distribution models for the waste sites in the OUs from the characterization of representative waste sites. The preliminary conceptual contaminant distribution models and the preliminary exposure model will be used to develop and evaluate remedial action alternatives applicable to the OU in a FS/closure plan. The RI/FS will form the basis for selecting a preferred remedial action in a proposed plan for the CPP sites (200-TW-1 OU) and RPP sites (200-TW-2 OU). The RPP sites will be incorporated into the RCRA permit through the permit modification process.

1.5 PROJECT ISSUES

Project issues include both the global issues that transcend the specific DQO project and the technical issues that are unique to the project. Both global and project technical issues have the potential to impact the sampling design or the DQOs for the project.

1.5.1 Global Issues

No global issues were identified during the interview meeting between Ecology, the U.S. Environmental Protection Agency (EPA), and the U.S. Department of Energy, Richland Operations Office (RL). At the external DQO meeting between EPA and RL, the preliminary action level for exposure to radionuclides was identified as a global issue. Current activities to evaluate cleanup levels are underway for the 100 and 300 Areas; similar activities will also be conducted for the 200 Areas. For the purpose of this DQO summary report, a preliminary action level of 100 mrem for annual dose exposure to radionuclides will be used to evaluate appropriate analytical requirements. This level falls in the representative range of potential cleanup standards based on current land-use assumptions, regulatory requirements, and other requirements. The actual cleanup standards will be proposed in the FS and proposed plan and will be approved in the ROD for the OU.

1.5.2 Project Technical Issues

The project's technical issues include the following:

- Characterization of the 200-TW-1 Scavenged Waste and 200-TW-2 Tank Waste OU waste sites must consider radiological control requirements for possible transuranic-contaminated soils at levels above the DOE definition for TRU of 100 nCi/g.

- If contaminated soils are present above the TRU level in the 200-TW-1 Scavenged Waste and 200-TW-2 Tank Waste OU waste sites, stringent health and safety restrictions will be imposed on workers and work practices. The presence of transuranic-contaminated soils

may unfavorably impact analytical costs, detection limits, analyte lists, and sample media disposal.

- Cave-in potential at the 216-B-7A and 216-B-7B Cribs may limit the data collection alternatives and unfavorably impact data quality at that site. Alternative drilling methods may have to be explored.

- Geologic data for the B/C cribs and trenches (sites 200-E-14, 216-B-14 through 216-B-34, and 216-B-52) are of limited quality. While none of these sites were identified as representative sites, an evaluation of this data gap will be conducted and is discussed in Section 3.0.

1.6 WASTE SITES AND OPERATING HISTORY

The 200-TW-1 Scavenged Waste and 200-TW-2 Tank Waste Group OUs consist of 64 waste sites located in the Hanford Site's 200 East and 200 West Areas, south of the 200 East Area. Figures 1-1 through 1-4 depict the location of the study areas relative to the 200 Areas. The 200-TW-1 OU includes 35 CPP sites and one UPR site that received mostly fission product-depleted (i.e., scavenged) liquid waste. The 200-TW-2 OU contains 27 RPP sites and one UPR site that received first- and second-cycle bismuth-phosphate process waste or tank waste. Most of the waste discharged to the soil column in these OUs was generated at T, B, and U Plants from 1942 through 1957.

1.6.1 Plant History

The T and B Plants were constructed in 1944. The buildings associated with 200-TW-1 and 200-TW-2 waste streams include the 221-T and 221-B canyon buildings and the 224-T and 224-B concentration buildings. The T and B Plants received and processed irradiated fuel rods from the 100 Area reactors. The spent reactor fuel was chemically separated and purified, resulting in plutonium and processing wastes. The spent fuel reprocessing operations ceased in 1956 at T Plant and in 1952 at B Plant.

The U Plant was constructed in 1944 based on the design of T and B Plants and was initially used to train personnel for the uranium/plutonium separation and purification operations conducted in T and B Plants. During the training phase, only water was used in the plant systems and no waste streams were generated. However, in 1951, U Plant was modified for the uranium recovery process (URP). From 1952 to 1958, U Plant was used to recover unprocessed uranium stored in the single-shell tanks for reuse in the reactor plants and for waste volume reduction at T and B Plants. A later operation conducted at U Plant was the "scavenging" or precipitation of long-lived fission products from the settling process before discharge to the soil column.

Liquid waste generated at T, B, and U Plants was routed to underground storage tanks (e.g., T, B, and BY tank farms) through an underground transfer system. The storage tanks were used to settle the heavier constituents out of the liquid effluents, forming sludge. The liquid supernatants

in the tanks were ultimately discharged to the soil column via the cribs, drains, trenches, and injection/reverse wells.

Cribs and drains were designed to inject or percolate wastewater into the soil column. French drains were generally constructed of steel or concrete pipe. Cribs are shallow excavations that are either backfilled with permeable material or are voids created by wooden or concrete structures. Cribs and drains typically received low-level radioactive waste for disposal, and most were designed to receive liquid until a specific retention, volume, or radionuclide capacity was met.

Trenches are shallow, long, narrow, unlined excavations and were often located adjacent to other trenches. Some of the trenches have been backfilled and marked as a single group of trenches.

Injection/reverse wells are encased holes that were drilled with the lower end either perforated or open to allow liquid to seep into the vadose zone. These units injected wastewater into the vadose soil and/or groundwater at depths greater than other waste sites. Injection wells were used for the disposal of early liquid wastes from T and B Plants. Liquid wastes were later rerouted to cribs and trenches. By 1955, injection wells were no longer used at the Hanford Site for disposal of liquid waste.

1.6.2 Process Information

The processes at T, B, and U Plants that generated the primary waste streams into the 200-TW-1 and 200-TW-2 OU waste sites included the following:

- Bismuth-phosphate separation process: Generated 221-T or 221-B Building waste streams, including dissolved cladding, metal waste, and first- and second-cycle waste streams.

- Lanthanum fluoride purification process: Generated 224-T or 224-B Building waste streams, including purification waste or lanthanum fluoride waste streams.

- Uranium recovery process (URP): Generated U Plant waste, including tributyl phosphate (TBP) or column waste, solvent recovery waste, acid recovery waste, off-gas condensate, and uranium trioxide or powdered waste streams.

- Scavenging (fission product precipitation) process: Generated the scavenged and in-tank scavenged waste, including the fission product waste streams.

- Plant shutdown and equipment decontamination process: Generated dilute washings of the waste streams mentioned above.

Figures 1-5 and 1-6 show graphical representations of the B, T, and U Plant processes and the corresponding waste streams that were discharged to the 200-TW-1 and 200-TW-2 OU waste sites.

Figure 1-5. Plant Processes and Waste Streams at the T and B Plants.

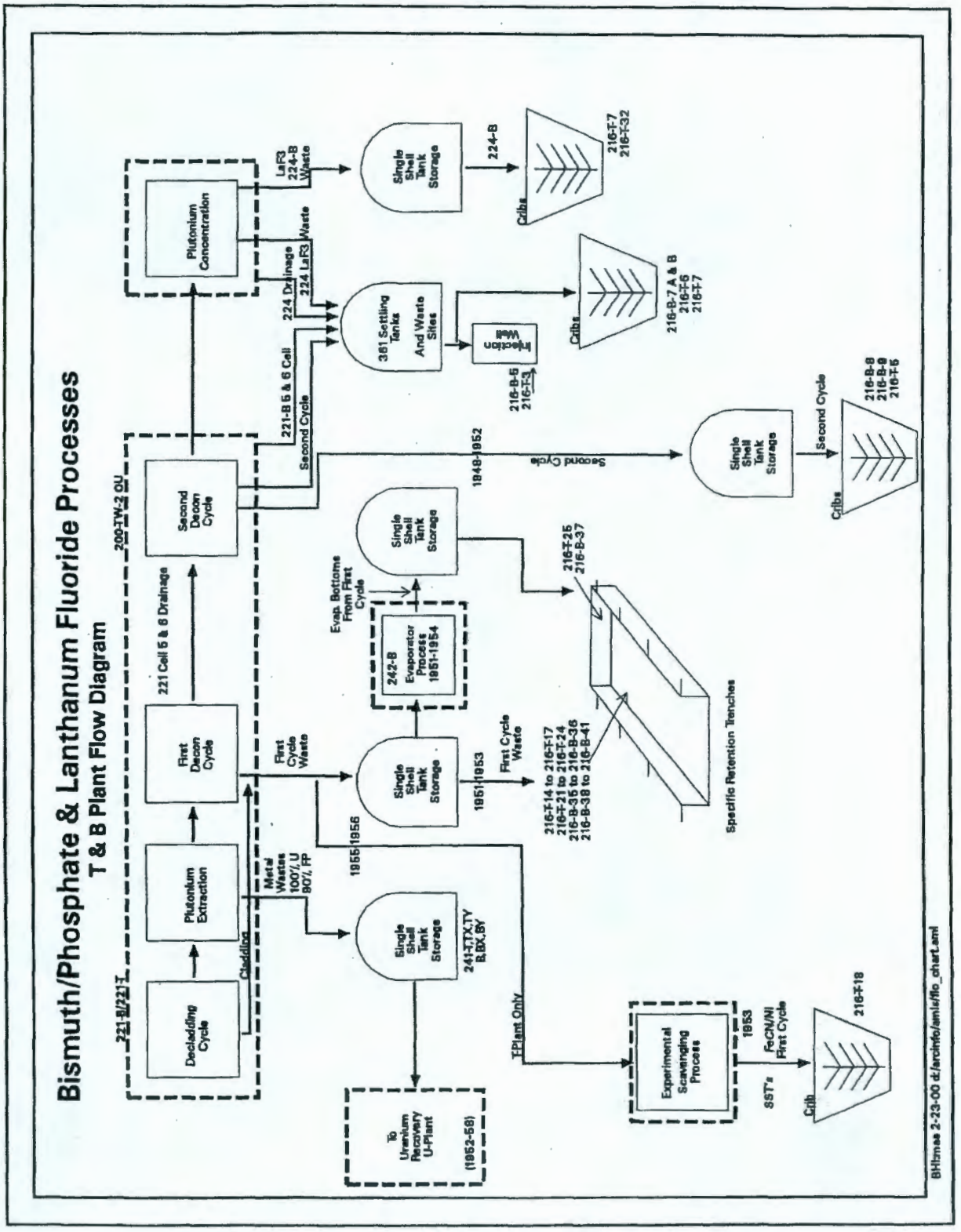
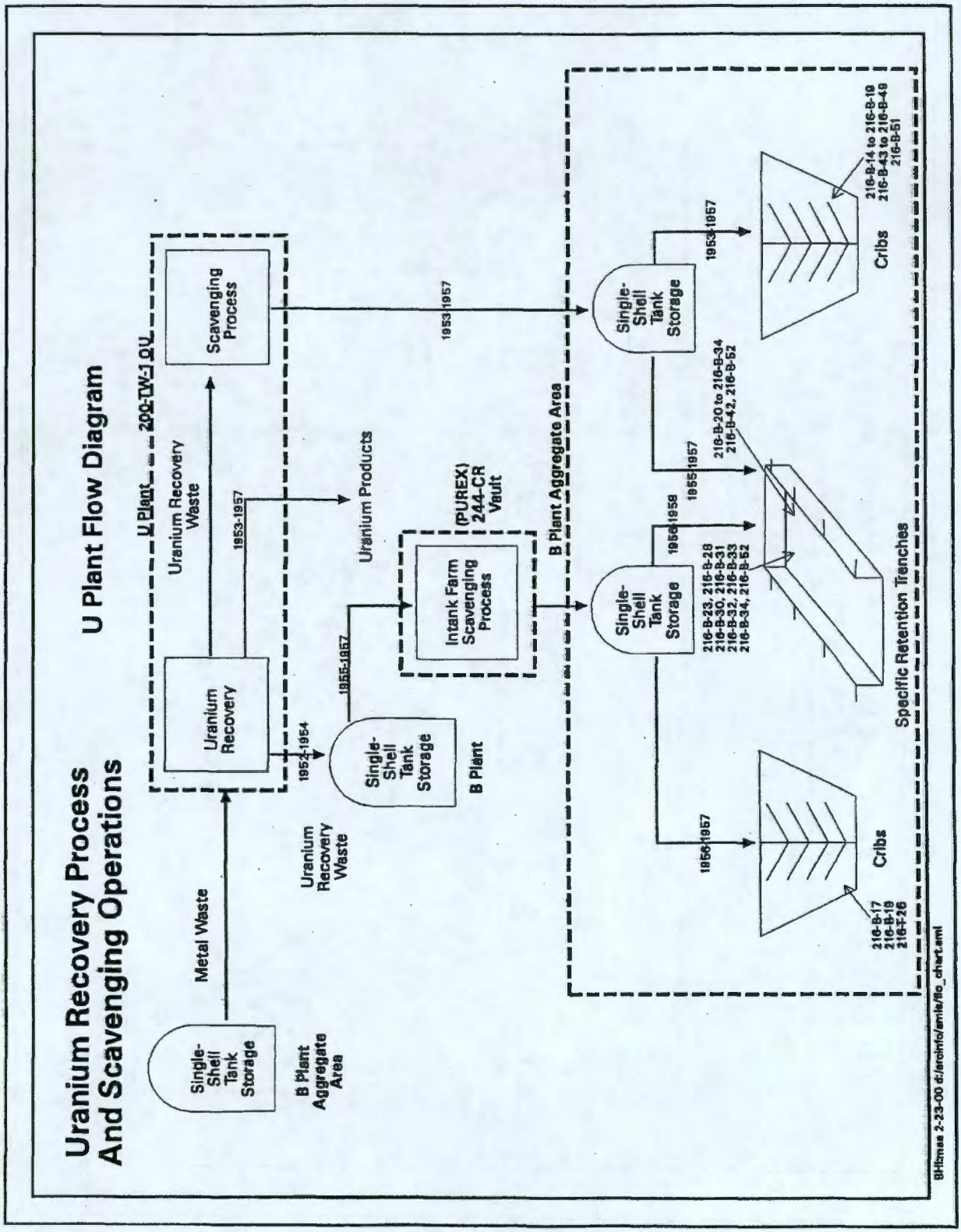


Figure 1-6. Plant Processes and Waste Streams at the U Plant.



1.7 WORKSHEETS FOR STEP 1 – STATE THE PROBLEM

Tables 1-1, 1-2, 1-3, and 1-4 identify the DQO scoping team members, DQO workshop team members, DQO integration team members, and key decision makers, respectively. The scoping team developed the checklist and binder prior to the internal seven-step process. The DQO workshop team members participated in the seven-step DQO process. The key decision makers provided external review of the results of the seven-step process.

Table 1-1. DQO Scoping Team Members.

Name	Organization	Area of Expertise (Role)
Roy Bauer	CHI Environmental Engineering	DQO Workbook/Facilitator
Janet Badden	CHI Regulatory Support/ Environmental Science	Regulatory
Karl Fecht	BHI Environmental Technologies	Geological
Russ Fabre	BHI Craft Supervisor	Field Support
Bruce Ford	BHI Site Assessments	BHI Project Manager
Moses Jarayssi	BHI Regulatory Support	Regulatory
Dave St. John	CHI Sample/Data Management	Sampling Data Management/Site Sampling History
Jim Sharpe	CHI Regulatory Support/ Environmental Science	Cultural/Biological Issues
Kevin Singleton	CH2M Hill, Inc.	Technical Staff, Author
Mary Todd	CHI Environmental Engineering	200-TW-1 and 200-TW-2 Task Lead
Wendy Thompson	BHI Environmental Technologies	Sampling/Field Analysis
Rich Weiss	CHI Sample/Data Management	Radiochemical and Analytical, Data Management
Jon Wiles	BHI Radiological Control Engineering	Radiological Control Engineering
Curt Wittreich	CHI Environmental Engineering	CHI Project Management
Michelle Yates	CHI Environmental Engineering	Technical Staff, Author

BHI=Bechtel Hanford, Inc.

CHI=CH2M Hill Hanford, Inc.

Table 1-2. DQO Workshop Team Members (2 pages)

Name	Organization	Area of Expertise (Role)
Roy Bauer	CHI Environmental Engineering	DQO Workbook/Facilitator
Mary Todd	CHI Environmental Engineering	200-TW-1 and 200-TW-2 Task Lead

Table 1-2. DQO Workshop Team Members (2 pages)

Name	Organization	Area of Expertise (Role)
Bruce Ford	BHI Site Assessments	BHI Project Manager
Wendy Thompson	BHI Environmental Technologies	Sampling/Field Analysis
Rich Weiss	CHI Sample/Data Management	Radiochemical and Analytical
Moses Jarayssi	BHI Regulatory Support	Regulatory Support
Jon Wiles	BHI Radiological Control Engineering	Radiological Control Engineering
Kevin Singleton	CH2M HILL, Inc.	Technical Staff/Author
Roger Ovink	CHI Regulatory Support	DQO Manager
Curt Wittreich	CHI Environmental Engineering	CHI Project Management

Table 1-3. DQO Integration Team Members

Name	Organization	Area of Expertise (Role)
Tony Knepp	CH2M HILL Group	RPP Tank Farm Manager
Peggy McCarthy	Los Alamos Technical Associates	RPP Support
Tom Jones	MAC Technical Services Company	RPP Chemistry
Marc Wood	Fluor Daniel Hanford, Inc.	RPP Geology
John Zachara	Pacific Northwest National Laboratory	S&T Manager
Brett Simpson	CH2M HILL Group	S&T Inventory

Table 1-4. DQO Key Decision Makers.

Name	Organization	Area of Expertise (Role)
Zelma Jackson	Ecology[a]	Ecology Project Manager
Bryan Foley	DOE	DOE Project Manager
Doug Sherwood	EPA[b]	EPA Project Manager

[a] Regulatory lead for 200-TW-2.
[b] Regulatory lead for 200-TW-1.
DOE = U.S. Department of Energy

Table 1-5 lists the key sources of existing documents and data collected from previous investigations that were reviewed by the DQO team.

Table 1-5. Existing Documents and Data Sources for 200-TW-1 and 200-TW-2 Operable Units. (5 pages)

Reference	Summary
200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program, DOE/RL-98-28, Rev. 0 (DOE-RL 1999)	Background geography, process, waste site, and COC knowledge and strategy for the 200 Areas.
200 Areas Waste Sites Handbook, 3 vols., RHO-CD-673 (Maxfield 1979)	Waste site descriptions, releases, waste discharge information, and management reports.
Phase I Remedial Investigation Report for 200-BP-1 Operable Unit, Vols. I and 2, DOE/RL-92-70, Rev. 0 (DOE-RL 1993c)	Summary of historical data, characterization information, and base-line risk assessment on 216-B-43 through 216-B-49 Cribs as part of 200-BP-1 OU effort. Atmospheric, biological, geological, and hydrological studies of contamination and contaminant distribution. Raw analytical data.
Hanford Engineer Works Technical Manual (T/B Plants), Parts A, B, and C, HW-10475 (GE 1944)	Process information on B, T, and U Plant facilities, chemicals used or stored, and operation and maintenance information, including process effluent sampling/analysis methods and theory behind the materials, chemicals, and equipment used during the bismuth-phosphate campaign. Results in this reference include general designation of waste streams generated and conclusive evidence that the bismuth-phosphate separation and the lanthanum fluoride purification processes were strictly inorganic in chemical nature.
Uranium Recovery Technical Manual, HW-19140 (GE 1951b)	Process information on U Plant facilities, chemicals used or stored, and operations and maintenance information, including process effluent sampling/analysis methods and theory behind the materials, chemicals, and equipment used during the URP campaign. Results in this reference include general designation of waste streams generated and conclusive evidence that the URP separation and the supplementary purification processes were strictly inorganic in chemical nature with the exception of TBP diluted in normal hydrocarbon paraffin.
Record of Scavenged TBP Waste (Logbook) (GE 1958)	Process information for 200-TW-1 OU waste sites including, operations, trouble shooting, chemicals used, and process effluent sampling data from 1950s. Results of a waste stream designation for the cribs and trenches containing the scavenged and URP waste streams.
An Assessment of the Inventories of the Ferrocyanide Watchlist Tanks, WHC-SD-WM-ER-133 (Borsheim and Simpson 1991)	Process information for 200-TW-1 OU waste sites including chemicals used, and modeling of liquid effluents discharged to soil and kept in tanks. Results of a waste stream designation and modeled inventories for the cribs and trenches containing the scavenged and URP waste streams.
216-B-5 Reverse Well Characterization Study, RHO-ST-37 (Smith 1980)	Radiological characterization data from the 216-B-5 reverse well and construction information.
Risk-Based Decision Analysis for the 200-BP-5 Groundwater Operable Unit, BHI-00416, Rev. 00 (BHI 1995)	Groundwater and risk assessment for 216-B-5 reverse well.
Hanford Site Atlas, BHI-01119, Rev. 1 (BHI 1998)	Site maps.
Pre-Operational Baseline and Site Characterization Report for the Environmental Restoration Disposal, Vols. 1 and 2, BHI-00270, Rev. 1 (BHI 1996)	Geological and groundwater information.

Table 1-5. Existing Documents and Data Sources for 200-TW-1 and 200-TW-2 Operable Units. (5 pages)

Reference	Summary
Hydrogeologic Conceptual Model for the Carbon Tetrachloride and Uranium/Technetium Plumes in the 200 West Area: 1994 to 1999 Update, BHI-01311, Rev. 0 (BHI 1999)	Geological and groundwater information.
Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford Site, PNL-7336 (Bjornstad 1990)	Geological information.
Underground Waste Disposal at Hanford Works, HW-671 (Brown and Ruppert 1948)	Historical waste site and COC disposal information.
The Underground Disposal of Liquid Wastes at Hanford Works, Washington, HW-17088 (Brown and Ruppert 1950)	Historical waste site and COC disposal information.
Vadose Zone Geology of the 241-B, 241-BX, and 241-BY Tank Farms, Hanford Site, South-Central Washington (Stephens et al. 1998)	Geologic information for B, BX, and BY tank farms. Used for comparison purposes.
Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells, ARH-ST-156 (Fecht et al. 1977)	Geophysical logs and contaminant distribution data.
200-BP-5 Operable Unit Technical Baseline Report, WHC-MR-0270 (Jacques and Kent 1991)	Background waste site information including pipelines, construction, and operational information.
Hanford Site Groundwater Monitoring for Fiscal Year 1998, PNNL-12086 (PNNL 1999)	Groundwater annual report information.
PNLATLAS/LG-ARCHV/200 East and West	Database for geophysical logging.
Hydrogeologic Model for the 200-East Groundwater Aggregate Area, WHC-SD-EN-TI-019, Rev. 0 (WHC 1992a)	Groundwater and geological information for 200 East Area waste sites.
Hydrogeologic Model for the 200-West Groundwater Aggregate Area, WHC-SD-EN-TI-014, Rev. 0 (WHC 1992b)	Groundwater and geological information for 200 West Area waste sites.
Geologic Setting of the Low-Level Burial Grounds, WHC-SD-EN-TI-290, Rev. 0 (WHC 1994)	Geological information.
Hanford Site Water Changes -- 1950 Through 1980, Data Observation and Evaluation, PNL-5506 (Zimmerman et al. 1986)	Groundwater maps of the Hanford Site.
History of Operations (1 January 1944 to 20 March 1945), OUT-1462 (HEW 1945)	Historical account of process operations information in the 100, 200, and 300 Areas. Trouble encountered, solutions implemented, chemical inventories, an overview of each processes' daily activities, building construction, functions, maintenance, and sampling, laboratory, and disposal activities.

Table 1-5. Existing Documents and Data Sources for 200-TW-1 and 200-TW-2 Operable Units. (5 pages)

Reference	Summary
Historical Vadose Zone Contamination from B, BX, and BY Tank Farm Operations, HNF-5231, Rev. 0 (Williams 1999)	COC comparison.
Removal of Organic Compounds from the "Contaminants of Concern" List for Tank Farm Vadose Zone Characterizations, HNF-5118 (Jones 1999)	COC information.
Hanford Tank Chemical and Radionuclide Inventories: HDW Model, LA-UR-96-3860, Rev. 4 (Agnew et al. 1997)	Scavenged and URP process waste and COC comparisons.
U Plant Source Aggregate Area Management Study Report, DOE/RL-91-52, Rev. 0 (DOE-RL 1992)	Process information on U Plant facilities, chemicals and radionuclides used and discharged, known and suspected contaminants, and a list of COPCs.
T Plant Source Aggregate Area Management Study Report, DOE/RL-91-61, Rev. 0 (DOE-RL 1993b)	Waste unit descriptions; maps with locations of waste units; preliminary conceptual site exposure model; summary of waste-producing processes in T Plant; known and suspected contaminants; affected media; results of soil, vadose zone, water, and biota sampling; plant buildings and waste discharge units (e.g., tanks, wells, vaults, ponds, ditches, trenches, septic systems, transfer lines and associated equipment, retention basins, and liquid effluent retention facilities); and site hazard rankings. Process history of T Plant aggregate area, waste management operations history, chemical waste inventories estimates, and history of UPRs.
B Plant Source Aggregate Area Management Study Report, DOE/RL-92-05, Rev. 0 (DOE-RL 1993a)	Waste unit descriptions; maps with locations of waste units; preliminary conceptual site exposure model; summary of waste-producing processes in B Plant; known and suspected contaminants; affected media; results of soil, vadose zone, water, and biota sampling; plant buildings and waste discharge units (e.g., tanks, wells, vaults, ponds, ditches, trenches, septic systems, transfer lines and associated equipment, retention basins, and liquid effluent retention facilities); and site hazard rankings. Process history of B Plant aggregate area, waste management operations history, chemical waste inventories estimates, and history of UPRs.
Tank Waste Discharge Directly to Soil at the Hanford Site, WHC-MR-0227 (WHC 1991)	Descriptions of waste units, site locations, and waste type summaries. Conclusions from previous studies, general model of contaminant distributions for cribs and trenches and process information overview.
Liquid Radioactive Waste Discharged from B-Plant to Cribs, WHC-SD-WM-ER-575, Rev. 0 (WHC 1996)	History of operations, process information on B Plant source facilities, and chemicals used or stored. Lists COCs and waste site information.

Table 1-5. Existing Documents and Data Sources for 200-TW-1 and 200-TW-2 Operable Units. (5 pages)

Reference	Summary
Process Waste Disposal Summary – 200 Areas (September 1949 through December 1950), HW-20583 (GE 1951a)	History of operations, process information of source facilities, and chemicals used or stored. Lists COCs and waste site information.
Summary of Liquid Radioactive Wastes Discharged to the Ground – 200 Areas (July 1952 through June 1954), HW-33591 (GE 1954b)	History of operations, process information of source facilities, and chemicals used or stored. Lists COCs and waste site information.
Radioactive Contamination in Liquid Wastes Discharged to Ground at Separation Facilities Through June 1955, HW-38562 (GE 1955)	History of operations, process information of source facilities, and chemicals used or stored. The COCs and waste site information.
200 Areas Disposal Sites for Radioactive Liquid Wastes, ARH-947 (Curren 1972)	Waste site and COC information.
Radionuclide Inventories of Liquid Waste Disposal Sites on the Hanford Site, HNF-1744 (FDH 1999)	Waste site and COC information.
Cobalt-60 in Groundwater and Separations Waste Streams, HW-42612 (GE 1956)	History of experiments, operations and scavenging process information, chemicals used, waste site information, and COCs.
Recovery of Cesium-137 from Uranium Recovery Process Wastes, HW-31442 (GE 1954a)	History of operations, process information of source facilities, and chemicals used or stored. Lists COC information.
Waste Site Grouping for 200 Areas Soil Investigations, DOE/RL-96-81, Rev. 0 (DOE-RL 1997)	Summarizes site name, location, type status, site and process descriptions, known and suspected contamination, preliminary contaminant distribution conceptual model, site conditions that may affect COC fate and transport, COC mobility in Hanford Site soils, COC distribution and transport to groundwater, and hazards associated with COCs. Soil porosity information for each waste site.

Table 1-5. Existing Documents and Data Sources for 200-TW-1 and 200-TW-2 Operable Units. (5 pages)

Reference	Summary
WIDS database reports: 200-TW-1: 216-E-14 storage tank, 216-B-14 Crib, 216-B-15 Crib, 216-B-16 Crib, 216-B-17 Crib, 216-B-18 Crib, 216-B-19 Crib, 216-B-20 Trench, 216-B-21 Trench, 216-B-22 Trench, 216-B-23 Trench, 216-B-24 Trench, 216-B-25 Trench, 216-B-26 Trench, 216-B-27 Trench, 216-B-28 Trench, 216-B-29 Trench, 216-B-30 Trench, 216-B-31 Trench, 216-B-32 Trench, 216-B-33 Trench, 216-B-34 Trench, 216-B-42 Trench, 216-B-43 Crib, 216-B-44 Crib, 216-B-45 Crib, 216-B-46 Crib, 216-B-47 Crib, 216-B-48 Crib, 216-B-49 Crib, 216-B-51 Crib, 216-B-52 Trench, 216-BY-201 settling tank, 216-T-18 Crib, 216-T-26 Crib, and UPR-200-E-9. 200-TW-2 OU: 216-B-5 reverse well, 216-B-7A and 216-B-7B Cribs, 216-B-8 Crib, 216-B-9 Crib, 216-B-35 Trench, 216-B-36 Trench, 216-B-37 Trench, 216-B-38 Trench, 216-B-39 Trench, 216-B-40 Trench, 216-B-41 Trench, 216-T-3 reverse well, 216-T-5 Trench, 216-T-6 Crib, 216-T-7 Crib, 216-T-14 Trench, 216-T-15 Trench, 216-T-16 Trench, 216-T-17 Trench, 216-T-21 Trench, 216-T-22 Trench, 216-T-23 Trench, 216-T-24 Trench, 216-T-25 Trench, 216-T-32 Crib, 241-B-361 settling tank, 241-T-361 settling tank, UPR-200-E-7	Summarizes site name, location, type, status, site and process descriptions, associated structures, clean-up activities, environmental monitoring description, access requirements, references, regulatory information, and waste information (e.g., type, category, physical state, description, and stabilizing activities).
Tank Characterization Database (at http://twins.pnl.gov:8001/TCD/main.html) (LHMC 1999)	Inactive miscellaneous underground storage tank search for tanks pertaining to 200-TW-1 and 200-TW-2 OU waste sites.
TRAC: A Preliminary Estimation of the Waste Inventories in Hanford Tanks Through 1980, WHC-SD-WM-TI-057 (Jungfleisch 1984)	Lists COCs and general inventory comparisons.
HEIS database	Well information and sampling data.
Interview with Mr. R. Hultgren and Mr. R. Knight (B Plant, 241-B Tank Farm Operator and Health Physicist and Laboratory, and 241-T Tank Farm personnel and Health Physicist)	Historical information on operations and practices at B and T Plants.
Site visit notes	Information on general site conditions.
Drawings	Construction "as-built" drawings of individual waste sites.

HEIS = Hanford Environmental Information System
WIDS = Waste Information Data System

Tables 1-6a and 1-6b represent the complete unconstrained set of COPCs that were, or could have been, discharged to the 200-TW-1 and 200-TW-2 OU waste sites, respectively. The master COPC list was then evaluated against a set of exclusion rationale to determine a final list of

project COCs. The COPCs that were excluded and the rationale for their exclusion are listed in Tables 1-7a and 1-7b.

Based on a review of process, operational, and waste discharge information from various sources (Table 1-5), the chemical behavior of the constituents was evaluated. Process knowledge indicates that the 200-TW-1 and 200-TW-2 OU waste streams were predominantly liquid effluent discharges from the B, BX, BY, T, TX, and TY tank farms. In general, the majority of the waste generated by operations associated with these waste sites can be described as acid neutralization, stabilization of highly reactive compounds, chemical oxidation/reduction, and metathesis reactions.

Table 1-6a. Sources of Contamination, COPCs, and Affected Media for the 200-TW-1 Operable Unit. (2 pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)	Affected Media
Tank waste discharges from T, B, and U Plants during the bismuth-phosphate campaign, uranium recovery, and scavenging operations.	Mixed fission products, activation products, transuranics, and neutral to basic inorganic chemicals.	Shallow soils (0 to 4.6 m [0 to 15 ft] bgs) and deep soils (>4.6 m [>15 ft]bgs) associated with the waste sites and potentially the groundwater beneath the waste sites.

Radioactive COPCs			
Americium-241	Curium-243	Palladium-107	Technetium-99
Americium-242	Curium-244	Plutonium-238	Tellurium-129m
Americium-243	Curium-245	Plutonium-239/240	Tellurium-129
Antimony-123	Europium-152	Plutonium-241/242	Thorium-232
Antimony-125	Europium-154	Praseodymium-143	Tin-123m
Barium-137	Europium-155	Praseodymium-144	Tin-123
Barium-137m	Iodine-129	Promethium-147	Tin-125
Barium-140	Lanthanium-140	Radium-226	Tin-126
Cadmium-113m	Neodymium-147	Radium-228	Tritium
Carbon-14	Neptunium-237	Rhodium-106	Uranium-232
Cerium-141	Neptunium-239	Ruthenium-103	Uranium-233/234
Cerium-144	Nickel-59	Ruthenium-106	Uranium-235/236
Cesium-134	Nickel-63	Samarium-149	Uranium-238
Cesium-135	Niobium-93m	Samarium-151	Yttrium-90
Cesium-137	Niobium-95	Selenium-79	Yttrium-91
Cobalt-60	Niobium-96	Strontium-89	Zirconium-93
Curium-242	Niobium-98	Strontium-90	Zirconium-95

Inorganic COPCs			
Aluminum	Ammonium oxalate Ammonium	Chromium	Iron sulfate
Ammonium cerium nitrate	fluosilicate	Chromium nitrate	Lanthanum
Aluminum fluoride	Ammonium sulfate	Copper	Lanthanum fluoride
Aluminum nitrate	Bismuth	Ferric ammonium sulfate	Lanthanum hydroxide
Aluminum nitrate nonahydrate	Bismuth subnitrate/oxynitrate	Ferric hydroxide	Lanthanum nitrate
Aluminum nitrate (mono basic)	Bismuth orthophosphate	Ferric nitrate	Lead
Aluminum silicate	Cadmium	Ferrous ammonium sulfate	Lead oxide
Aluminum sulfate	Calcium	Ferro/ferric cyanide	Magnesium
Ammonia	Calcium carbonate (lime)	Ferrous sulfamate	Magnesium nitrate
Ammonium hydroxide	Calcium nitrate	Fluoride	Manganese
Ammonium iron fluoride	Cerium	Hydrochloric acid	Manganese oxide
Ammonium iron sulfate	Cerium phosphate	Hydrofluoric acid	Manganese nitrate
Ammonium lanthanum nitrate	Cesium nitrate	Hydrogen	Mercury
	Cesium phosphate	Hydrogen peroxide	Molybdenum
	Chloride	Hydroxide	Nickel
	Chromic acid	Iron	Nickel sulfate

Table 1-6a. Sources of Contamination, COPCs, and Affected Media for the 200-TW-1 Operable Unit. (2 pages)

Inorganic Chemical COPCs			
Nitrate	Potassium fluoride	Sodium metabismuthate	Sulfate
Nitrite	Potassium nitrate	Sodium nitrate	Sulfite
Nitric acid	Potassium permanganate	Sodium nitrite	Sulfuric acid
Peroxide	Silicon	Sodium oxalate	Tin
Phosphate	Silver	Sodium silicate	Tungsten
Phosphoric acid	Sodium	Sodium sulfate	Uranium
Plutonium	Sodium aluminate	Sodium hydrogen sulfate	Uranium dioxide
Plutonium fluoride	Sodium bicarbonate	Sodium phosphate	Uranium trioxide
Plutonium dioxide	Sodium carbonate	Disodium phosphate	Uranyl nitrate
Plutonium nitrate	Sodium chloride	Sodium pyrophosphate	Vanadium
Plutonium peroxide	Sodium dichromate	Sodium uranyl carbonate	Zinc
Potassium	Sodium fluoride	Disodium uranyl oxide	Zinc nitrate
Potassium carbonate	Sodium hexametaphosphate (calgon)	Strontium (metal)	Zinc phosphate
Potassium chloride Potassium dichromate	Sodium hydroxide	Strontium carbonate	Zirconium
Potassium hydroxide		Strontium nitrate	Zirconium carbonate gel
		Sulfamic acid	Zirconyl nitrate
Organic Chemical COPCs			
AMSCO	Normal paraffins	Super gel hyflo	Tributyl phosphate
Citrate	Oxalate	Tetrasodium ethylene diamine tetra-acetate (EDTA)	Trisodium hydroxyethyl ethylene – diamine triacetate (HEDTA)
Dibutyl phosphate	Polychlorinated biphenyls (PCBs)		
Kerosene			
Monobutyl phosphate			

Table 1-6b. Sources of Contamination, COPCs, and Affected Media for the 200-TW-2 Operable Unit. (2 pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)	Affected Media
Tank waste discharges from T and B Plants during the bismuth-phosphate campaign.	Mixed fission products, activation products, transuranics, and neutral to basic, inorganic chemicals.	Shallow soils (0 to 4.6 m [0 to 15 ft] bgs) and deep zone soils (>4.6 m [>15 ft] bgs) associated with the waste sites and potentially the groundwater beneath the waste sites.

Radioactive COPCs			
Americium-241	Curium-243	Palladium-107	Technetium-99
Americium-242	Curium-244	Plutonium-238	Tellurium-129m
Americium-243	Curium-245	Plutonium-239/240	Tellurium-129
Antimony-123	Europium-152	Plutonium-241/242	Thorium-232
Antimony-125	Europium-154	Praseodymium-143	Tin-123m
Barium-137	Europium-155	Praseodymium-144	Tin-123
Barium-137m	Iodine-129	Promethium-147	Tin-125
Barium-140	Lanthanium-140	Radium-226	Tin-126
Cadmium-113m	Neodymium-147	Radium-228	Tritium
Carbon-14	Neptunium-237	Rhodium-106	Uranium-232
Cerium-141	Neptunium-239	Ruthenium-103	Uranium-233/234
Cerium-144	Nickel-59	Ruthenium-106	Uranium-235/236
Cesium-134	Nickel-63	Samarium-149	Uranium-238
Cesium-135	Niobium-93m	Samarium-151	Yttrium-90
Cesium-137	Niobium-95	Selenium-79	Yttrium-91
Cobalt-60	Niobium-96	Strontium-89	Zirconium-93
Curium-242	Niobium-98	Strontium-90	Zirconium-95

Table 1-6b. Sources of Contamination, COPCs, and Affected Media for the 200-TW-2 Operable Unit. (2 pages)

Inorganic COPCs			
Aluminum Ammonium cerium nitrate Aluminum fluoride Aluminum nitrate Aluminum nitrate nonahydrate Aluminum nitrate (mono basic) Aluminum silicate Aluminum sulfate Ammonia Ammonium hydroxide Ammonium iron fluoride Ammonium iron sulfate Ammonium lanthanum nitrate	Ammonium oxalate Ammonium fluosilicate Ammonium sulfate Bismuth Bismuth subnitrate/oxynitrate Bismuth orthophosphate Cadmium Calcium Calcium carbonate (lime) Calcium nitrate Cerium Cerium phosphate Cesium nitrate Cesium phosphate Chloride	Chromic acid Chromium Chromium nitrate Copper Ferric ammonium sulfate Ferric hydroxide Ferric nitrate Ferrous ammonium sulfate Fluoride Hydrochloric acid Hydrofluoric acid Hydrogen Hydrogen peroxide Hydroxide Iron	Iron sulfate Lanthanum Lanthanum fluoride Lanthanum hydroxide Lanthanum nitrate Lead Lead oxide Magnesium Magnesium nitrate Manganese Manganese oxide Manganese nitrate Mercury Molybdenum Nickel Nickel sulfate
Inorganic Chemical COPCs			
Nitrate Nitrite Nitric acid Peroxide Phosphate Phosphoric acid Plutonium Plutonium fluoride Plutonium dioxide Plutonium nitrate Plutonium peroxide Potassium Potassium carbonate Potassium chloride Potassium dichromate Potassium hydroxide	Potassium fluoride Potassium nitrate Potassium permanganate Silicon Silver Sodium Sodium aluminate Sodium bicarbonate Sodium carbonate Sodium chloride Sodium dichromate Sodium fluoride Sodium hexametaphosphate (Calgon) Sodium hydroxide	Sodium metabismuthate Sodium nitrate Sodium nitrite Sodium oxalate Sodium silicate Sodium sulfate Sodium hydrogen sulfate Sodium phosphate Disodium phosphate Sodium pyrophosphate Sodium uranyl carbonate Disodium uranyl oxide Strontium (metal) Strontium carbonate Strontium nitrate	Sulfate Sulfite Sulfuric acid Tin Tungsten Uranium Uranium dioxide Uranium trioxide Uranyl nitrate Vanadium Zinc Zinc nitrate Zinc phosphate Zirconium Zirconium carbonate gel Zirconyl nitrate
Organic Chemical COPCs			
Citrate Oxalate	PCBs Super gel hyflo	Tetrasodium ethylene diamine tetra-acetate (EDTA)	Trisodium hydroxyethyl ethylene – diamine triacetate (HEDTA)

The first step in the evaluation process involved extracting known toxic materials from the master COPC list for placement on the final COC list. Inorganic salts represent a large group of constituents in the waste sites being evaluated. Because laboratory analyses are generally not compound-specific, the inorganic salts were excluded from further consideration. Instead, the readily detected anions (e.g., fluorides and nitrates) associated with the inorganic salts serve as the target constituents for those compounds. This logic recognizes the small volumes of wastes released into large-volume aqueous discharges.

The analytical approach employed for this project generally targets the significant risk drivers that are representative of the waste constituents present. The general suite-type analytical techniques yield results on many metals and organic compounds, providing a cost-effective approach for the known toxic materials that could be present.

The COPCs in the following categories were dropped from further consideration:

- Short-lived radionuclides with half-lives less than 3 years
- Radionuclides that constitute less than 1% of the fission product inventory and for which historical sampling indicates nondetection
- Naturally occurring isotopes that were not created as a result of Hanford Site operations
- Constituents with atomic mass numbers greater than 242 that represent less than 1% of the actinide activities
- Progeny radionuclides that build insignificant activities within 50 years and/or for which parent/progeny relationships exist that permit progeny estimation
- Constituents that would be neutralized and/or decomposed by facility processes
- Chemicals in a gaseous state that cannot accumulate in soil media
- Chemicals used in minor quantities relative to the bulk production chemicals consumed in the normal processes; these chemicals are not likely to be present in toxic or high concentrations
- Chemicals that are not persistent in the environment due to biological degradation or other natural mitigating features.

Table 1-7a. 200-TW-1 Operable Unit COPC Exclusions and Justifications. (4 pages)

COPCs	Rationale for Exclusion
Radionuclides	
Americium-242	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Americium-243	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Antimony-123	Stable.
Antimony-125	Short-lived radionuclide (half-life <3 years).
Barium-137	Stable.
Barium-137m	Short-lived daughter of Cs-137 (which is a final COPC).
Barium-140	Short-lived radionuclide (half-life <3 years).
Cadmium-113m	Less than 1% of Cs-137 activity. Insignificant contribution to dose.
Cerium-141	Short-lived radionuclide (half-life <3 years).
Cerium-144	Short-lived radionuclide (half-life <3 years).
Cesium-134	Short-lived radionuclide (half-life <3 years).
Cesium-135	Constituent generated at less than 5E-5 times the Cs-137 activity.
Curium-242	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Curium-243	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Curium-244	Constituent with atomic mass number greater than or equal to 242 that represents less than 1% of the actinide activity. May be reported via americium isotopic analysis.

Table 1-7a. 200-TW-1 Operable Unit COPC Exclusions and Justifications. (4 pages)

COPCs	Rationale for Exclusion
Curium-245	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Iodine-129	Constituent generated at less than 5E-5 times the Cs-137 activity; historical tank sampling indicates nondetection.
Lanthanum-140	Short-lived radionuclide (half-life <3 years).
Neodymium-147	Short-lived radionuclide (half-life <3 years).
Neptunium-239	Short-lived radionuclide (half-life <3 years).
Nickel-59	Activity will be <5% of Ni-63 activity and may be estimated from that isotope.
Niobium-93m	Constituent generated at less than 5E-5 times the Cs-137 activity.
Niobium-95	Short-lived radionuclide (half-life <3 years).
Niobium-96	Short-lived radionuclide (half-life <3 years)
Niobium-98	Short-lived radionuclide (half-life <3 years)
Palladium-107	Constituent generated at less than 5E-5 times the Cs-137 activity.
Plutonium-241	Not detected by normal plutonium analysis, can infer from americium/plutonium results.
Plutonium-242	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Praseodymium-143	Short-lived radionuclide (half-life <3 years).
Praseodymium-144	Short-lived radionuclide (half-life <3 years).
Promethium-147	Short-lived radionuclide (half-life <3 years).
Rhodium-106	Short-lived radionuclide (half-life <3 years).
Ruthenium-103	Short-lived radionuclide (half-life <3 years).
Ruthenium-106	Short-lived radionuclide (half-life <3 years).
Samarium-149	Stable.
Samarium-151	Less than 1% of Cs-137 activity. Insignificant contribution to dose.
Selenium-79	Constituent generated at less than 5E-5 times the Cs-137 activity.
Strontium-89	Short-lived radionuclide (half-life <3 years).
Tellurium-129m	Short-lived radionuclide (half-life <3 years).
Tellurium-129	Short-lived radionuclide (half-life <3 years).
Tin-123m	Short-lived radionuclide (half-life <3 years).
Tin-123	Short-lived radionuclide (half-life <3 years).
Tin-125	Short-lived radionuclide (half-life <3 years).
Tin-126	Constituent generated at less than 5E-5 times the Cs-137 activity. (GEA will report if detected.)
Uranium-232	<2x 10-3 times the U-238 activity.
Uranium-233	Measurement cannot resolve U-233 + U-234 isotopes, reported as U-234 or U-233/234.
Uranium-236	Measurement cannot resolve U-235 + U-236 isotopes, reported as U-235.
Yttrium-90	Short-lived daughter of Sr-90 (which is a final COPC).
Yttrium-91	Short-lived radionuclide (half-life <3 years).
Zirconium-93	Constituent generated at less than 5E-5 times the Cs-137 activity.
Zirconium-95	Short-lived radionuclide (half-life <3 years).
Inorganics	
Aluminum	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Bismuth	This inorganic substance is unlikely to be present in toxic concentrations.
Calcium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Carbonate(axb)	This inorganic substance is unlikely to be present in toxic concentrations.
Cerium	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use in Hanford 200 Area processes.
Cesium	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use in Hanford 200 Area processes.

Table 1-7a. 200-TW-1 Operable Unit COPC Exclusions and Justifications. (4 pages)

COPCs	Rationale for Exclusion
Hydrogen	Gas.
Hydroxide	Assessed via pH determination.
Iron	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Lanthanum	This inorganic substance is unlikely to be present in toxic concentrations.
Magnesium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Manganese	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Molybdenum	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Peroxide	Has degraded.
Potassium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Silicon	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use in Hanford 200 Area processes.
Sodium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Strontium	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use in Hanford 200 Area processes.
Sulfamates	Has degraded to sulfates.
Sulfite	Used in minimal quantities at Hanford. Reactive material with minimal lifetime in Hanford environment.
Tin	This inorganic substance is unlikely to be present in toxic concentrations.
Vanadium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Tungsten	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use in Hanford 200 Area processes.
Zinc	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Zirconium	This inorganic substance is unlikely to be present in toxic concentrations.
Organics	
Citric acid	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Dibutyl phosphate	No direct standard analytical technique available. This compound is a degradation product of tributyl phosphate and is unlikely to be present in toxic or high concentrations.
Ethylene-diamine tetra acetic acid (EDTA)	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Monobutyl phosphate	No direct standard analytical technique available. This compound is a degradation product of tributyl phosphate and is unlikely to be present in toxic or high concentrations.
Oxalic acid	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
PCBs	During the sampling and analysis effort at the BY cribs it is documented in 200-BP-1 OU that one of 52 near-surface and 3 of 77 subsurface samples analyzed for PCBs were detected at levels less than 1 mg/kg. Only one of the samples exceeded MTCA Method B values (0.77 mg/kg versus 0.50 mg/kg), none of the samples exceeded MTCA Method C values, all four samples were near detection limits, and all four samples were qualified as estimated values.

Table 1-7a. 200-TW-1 Operable Unit COPC Exclusions and Justifications. (4 pages)

COPCs	Rationale for Exclusion
Super gel hyflo	A chromatography medium that was used in determining if samples collected from various steps of the bismuth-phosphate process had successfully reacted, separated, etc. This organic substance is unlikely to be present in toxic concentrations.
Trisodium hydroxyethyl ethylene-diamine tri-aceatate (HEDTA)	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.

GEA = gamma energy analysis
ICP = inductively coupled plasma

Table 1-7b. 200-TW-2 Operable Unit COPC Exclusions and Justifications. (3 pages)

COPCs	Rationale for Exclusion
Radionuclides	
Americium-242	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Americium-243	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Antimony-123	Stable.
Antimony-125	Short-lived radionuclide (half-life <3 years).
Barium-137	Stable.
Barium-137m	Short-lived daughter of Cs-137 (which is a final COPC).
Barium-140	Short-lived radionuclide (half-life <3 years).
Cadmium-113m	Less than 1% of Cs-137 activity. Insignificant contribution to dose.
Cerium-141	Short-lived radionuclide (half-life <3 years).
Cerium-144	Short-lived radionuclide (half-life <3 years).
Cesium-134	Short-lived radionuclide (half-life <3 years).
Cesium-135	Constituent generated at less than 5E-5 times Cs-137 activity.
Curium-242	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Curium-243	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Curium-244	Constituent with atomic mass number greater than or equal to 242 that represents less than 1% of the actinide activity. May be reported via americium isotopic analysis.
Curium-245	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Iodine-129	Constituent generated at less than 5E-5 times Cs-137 activity, historical tank sampling indicates nondetection.
Lanthanum-140	Short-lived radionuclide (half-life <3 years).
Neodymium-147	Short-lived radionuclide (half-life <3 years).
Neptunium-239	Short-lived radionuclide (half-life <3 years).
Nickel-59	Activity will be < 5% of Ni-63 activity and may be estimated from that isotope.
Niobium-93m	Constituent generated at less than 5E-5 times Cs-137 activity.
Niobium-95	Short-lived radionuclide (half-life <3 years).

Table 1-7b. 200-TW-2 Operable Unit COPC Exclusions and Justifications. (3 pages)

COPCs	Rationale for Exclusion
Niobium-96	Short-lived radionuclide (half-life <3 years).
Niobium-98	Short-lived radionuclide (half-life <3 years).
Palladium-107	Constituent generated at less than 5E-5 times Cs-137 activity.
Plutonium-241	Not detected by normal Pu analysis, can infer from americium/plutonium results.
Plutonium-242	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGIN2 modeling of Hanford reactor production).
Praseodymium-143	Short-lived radionuclide (half-life <3 years).
Praseodymium-144	Short-lived radionuclide (half-life <3 years).
Promethium-147	Short-lived radionuclide (half-life <3 years).
Rhodium-106	Short-lived radionuclide (half-life <3 years).
Ruthenium-103	Short-lived radionuclide (half-life <3 years).
Ruthenium-106	Short-lived radionuclide (half-life <3 years).
Samarium-149	Stable.
Samarium-151	Less than 1% of Cs-137 activity. Insignificant contribution to dose.
Selenium-79	Constituent generated at less than 5E-5 times Cs-137 activity.
Strontium-89	Short-lived radionuclide (half-life <3 years).
Tellurium-129m	Short-lived radionuclide (half-life <3 years).
Tellurium-129	Short-lived radionuclide (half-life <3 years).
Tin-123m	Short-lived radionuclide (half-life <3 years).
Tin-123	Short-lived radionuclide (half-life <3 years).
Tin-125	Short-lived radionuclide (half-life <3 years).
Tin-126	Constituent generated at less than 5E-5 times Cs-137 activity (GEA will report if detected).
Uranium-232	<2x 10-3 times U-238 activity.
Uranium-233	Measurement cannot resolve U-233 + U-234 isotopes, reported as U-234 or U-233/234.
Uranium-236	Measurement cannot resolve U-235 + U-236 isotopes, reported as U-235.
Yttrium-90	Short-lived daughter of Sr-90 (which is a final COPC).
Yttrium-91	Short-lived radionuclide (half-life <3 years).
Zirconium-93	Constituent generated at less than 5E-5 times Cs-137 activity.
Zirconium-95	Short-lived radionuclide (half-life <3 years).
Inorganics	
Aluminum	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Bismuth	This inorganic substance is unlikely to be present in toxic concentrations.
Calcium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Carbonate(axb)	This inorganic substance is unlikely to be present in toxic concentrations.
Cerium	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use in Hanford 200 Area processes.
Cesium	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use in Hanford 200 Area processes.
Hydrogen	Gas.
Hydroxide	Assessed via pH determination.
Iron	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.

Table 1-7b. 200-TW-2 Operable Unit COPC Exclusions and Justifications. (3 pages)

COPCs	Rationale for Exclusion
Lanthanum	This inorganic substance is unlikely to be present in toxic concentrations.
Magnesium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Manganese	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Molybdenum	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Peroxide	Has degraded.
Potassium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Silicon	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use in Hanford 200 Area processes.
Sodium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Strontium	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use in Hanford 200 Area processes.
Sulfite	Used in minimal quantities at Hanford. Reactive material with minimal lifetime in Hanford environment.
Tin	This inorganic substance is unlikely to be present in toxic concentrations.
Vanadium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Tungsten	This inorganic substance is unlikely to be present in toxic or high concentrations due minimal use in Hanford 200 Area processes.
Zinc	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Zirconium	This inorganic substance is unlikely to be present in toxic concentrations.
Organics	
Citric acid	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Ethylene-diamine tetra-acetic acid (EDTA)	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Oxalic acid	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
PCBs	During the sampling and analysis effort at the BY cribs, it is documented in 200-BP-1 OU that one of 52 near-surface and 3 of 77 subsurface samples analyzed for PCBs were detected, all at levels less than 1 mg/kg. Only one of the samples exceeded MTCA Method B values (0.77 mg/kg versus 0.50 mg/kg), none of the samples exceeded MTCA Method C values, all four samples were near detection limits, and all four samples were qualified as estimated values.
Super gel hyflo	A chromatography medium that was used in determining if samples collected from various steps of the bismuth-phosphate process had successfully reacted, separated, etc. This organic substance is unlikely to be present in toxic concentrations.
Trisodium hydroxyethyl ethylene-diamine tri-aceatate (HEDTA)	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.

Tables 1-8a and 1-8b include the final lists of COCs for the 200-TW-1 and 200-TW-2 OUs, respectively, with the rationale for inclusion for each of the COCs.

Table 1-8a. 200-TW-1 Operable Unit Final COC List. (3 pages)

Final COCs	Rationale for Inclusion
Radiological Constituents	
Americium-241	Known production from fission reaction and listed via tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991).
Carbon-14	Known fission product and listed via tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991).
Cesium-137	Known fission product (GE 1944 [Sections A, B, and C], GE 1951b).
Cobalt-60	Known fission product (GE 1944 [Sections A, B, and C], GE 1951b, WHC 1991).
Europium-152	Known fission product (GE 1944 [Sections A, B, and C], FDH 1999).
Europium-154	Known fission product (GE 1944 [Sections A, B, and C], FDH 1999).
Europium-155	Known fission product (GE 1944 [Sections A, B, and C], GE 1951b).
Hydrogen-3	Known fission product and listed via tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991).
Neptunium-237	Known production from fission reaction and listed via tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991).
Nickel-63	Known fission product and listed via tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991).
Plutonium-238	Known production from fission reaction (GE 1944, Sections A, B, and C).
Plutonium-239/240	Known production from fission reaction (GE 1944, Sections A, B, and C).
Radium-226	Known production from fission reaction and listed via tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991).
Radium-228	Known production from fission reaction and listed via tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991).
Strontium-90	Known fission product (GE 1944 [Sections A, B, and C], GE 1951b). Analyzed as total radioactive strontium.
Technetium-99	Known fission product (GE 1944 [Sections A, B, and C], WHC 1991).
Thorium-232	Known production from fission reaction (GE 1944 [Sections A, B, and C], FDH 1999).
Uranium-234	Known production from fission reaction (GE 1944, Sections A, B, and C).
Uranium-235	Known production from fission reaction (GE 1944, Sections A, B, and C).
Uranium-238	Known production from fission reaction (GE 1944, Sections A, B, and C).
Nonradiological Constituents – Metals	
Cadmium	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944, Section A).
Chromium	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990).
Chromium (VI)	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990).
Copper	Metal used in triple-dip process of cladding and cladding waste stream (1944 to 1952) (GE 1944, Section A).
Lead	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944, Section A). Lead oxide was added as an oxidizing agent to the first- and second-cycle decontamination operations of bismuth-phosphate process (GE 1944, Section C).

Table 1-8a. 200-TW-1 Operable Unit Final COC List. (3 pages)

Final COCs	Rationale for Inclusion
Lead	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944, Section A). Lead oxide was added as an oxidizing agent to the first- and second-cycle decontamination operations of bismuth-phosphate process (GE 1944, Section C).
Mercury	Several uses in bismuth-phosphate campaign including addition to cladding and metal waste streams to prevent gaseous generations and misc. Laboratory uses. Listed by the basis of knowledge gained by interviews and via tank farm integration (Agnew et al. 1997).
Nickel	Experimental additions of nickel sulfate added during the bismuth-phosphate process to serve as a scavenging agent. Listed as a result of tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991) and extensive use (1954 to 1958) as nickel ferro/ferric cyanide during scavenging and recovery processes (GE 1951b).
Silver	Several uses in bismuth-phosphate campaign including filtering of gases generated (1950s) and miscellaneous laboratory uses. Listed on the basis of knowledge gained by interviews.
Nonradiological Constituents – General Inorganics	
Ammonia/ammonium	Several compounds contained ammonium. The most widely used included ammonium silica fluoride, which was used as a cleaning and decontamination compound based on the ability to dissolve metals and fission products (GE 1944 [Section C], GE 1951b, HEW 1945).
Chloride	Several compounds contained chloride. The most widely used included ferrous chloride, which was used as a carrier and potassium/sodium chloride used as salting agents during the bismuth-phosphate process (GE 1944 [Section C], GE 1951b, HEW 1945).
Cyanide	Extensive use (1954 to 1958) as nickel ferro/ferric cyanide during scavenging and recovery processes. Listed as a result of tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991, GE 1951b).
Fluoride	Several compounds contained fluoride. The most widely used included lanthanum fluoride (which was used during the concentration operations of the bismuth-phosphate process) and ammonium silica fluoride (which was used as a cleaning and decontamination compound based on ability to dissolve metals and fission products) (GE 1944 [Section C], GE 1951b, HEW 1945).
Nitrate/nitrite	Several compounds contained nitrates/nitrites the most widely used included sodium nitrite, a salting agent during the cladding removal, nitric acid, used throughout the bismuth-phosphate process and URP, and bismuth subnitrate, which was used to create the bismuth-phosphate/plutonium solid during the first and second decontamination cycles (GE 1944 [Section C], GE 1951b, HEW 1945).
Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process (GE 1944 [Section C], HEW 1945).
Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in dissolving the fuel rods during the bismuth-phosphate process (GE 1944 [Section C], GE 1951b, HEW 1945). Other sulfate complexes were used as carriers for various metals.

Table 1-8a. 200-TW-1 Operable Unit Final COC List. (3 pages)

Final COCs	Rationale for Inclusion
Semi-Volatile Organics	
AMSCO[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in the URP (GE 1951b).
Dodecane[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in the URP (GE 1951b).
Normal paraffins[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in URPs (GE 1951b).
Tributyl phosphate and derivatives (mono, bi)	Extensive use (1953 to 1957) in solvent extraction operation as the bismuth-phosphate complexent in the URPs (GE 1951b).

[a] Analyzed as kerosene total petroleum hydrocarbons.

Table 1-8b. 200-TW-2 Operable Unit Final COC List. (3 pages)

Final COCs	Rationale for Inclusion
Radiological Constituents	
Americium-241	Known production from fission reaction and listed via tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991).
Carbon-14	Known fission product and listed via tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991).
Cesium-137	Known fission product (GE 1944 [Sections A, B, and C], GE 1951b).
Cobalt-60	Known fission product (GE 1944 [Sections A, B, and C], GE 1951b, WHC 1991).
Europium-152	Known fission product (GE 1944 [Sections A, B, and C], FDH 1999).
Europium-154	Known fission product (GE 1944 [Sections A, B, and C], FDH 1999).
Europium-155	Known fission product (GE 1944 [Sections A, B, and C], GE 1951b)
Hydrogen-3	Known fission product and listed via tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991).
Neptunium-237	Known production from fission reaction and listed via tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991).
Nickel-63	Known fission product and listed via tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991).
Plutonium-238	Known production from fission reaction (GE 1944, Sections A, B, and C).
Plutonium-239/240	Known production from fission reaction (GE 1944, Sections A, B, and C).
Radium-226	Known production from fission reaction and listed via tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991).
Radium-228	Known production from fission reaction and listed via tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991).
Strontium-90	Known fission product (GE 1944 [Sections A, B, and C], GE 1951b). Analyzed as total radioactive strontium.
Technetium-99	Known fission product (GE 1944 [Sections A, B, and C], WHC 1991).
Thorium-232	Known production from fission reaction (GE 1944 [Sections A, B, and C], FDH 1999).
Uranium-234	Known production from fission reaction fission product (GE 1944, Sections A, B, and C).
Uranium-235	Known production from fission reaction (GE 1944, Sections A, B, and C).
Uranium-238	Known production from fission reaction (GE 1944, Sections A, B, and C).

Table 1-8b. 200-TW-2 Operable Unit Final COC List. (3 pages)

Final COCs	Rationale for Inclusion
Nonradiological Constituents – Metals	
Cadmium	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944, Section A).
Chromium	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990).
Chromium (VI)	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990).
Copper	Metal used in triple-dip process of cladding and cladding waste stream (1944 to 1952) (GE 1944, Section A)
Lead	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944, Section A). Lead oxide was added as an oxidizing agent to the first- and second-cycle decontamination operations of bismuth-phosphate process (GE 1944, Section C).
Mercury	Several uses in bismuth-phosphate campaign including addition to cladding and metal waste streams to prevent gaseous generations and miscellaneous laboratory uses. Listed by the basis of knowledge gained by interviews and via tank farm integration (Agnew et al. 1997).
Nickel	Experimental additions of nickel sulfate added during the bismuth-phosphate process to serve as a scavenging agent. Listed as a result of tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991) and extensive use (1954 to 1958) as nickel ferro/ferric cyanide during scavenging and recovery processes (GE 1951b)
Silver	Several uses in bismuth-phosphate campaign including filtering of gases generated (1950s) and miscellaneous laboratory uses. Listed by the basis of knowledge gained by interviews.
Nonradiological Constituents – General Inorganics	
Ammonia/ammonium	Several compounds contained ammonium. The most widely used included ammonium silica fluoride, which was used as a cleaning and decontamination compound based on its ability to dissolve metals and fission products (GE 1944 [Section C], GE 1951b, HEW 1945).
Chloride	Several compounds contained chloride. The most widely used included ferrous chloride, which was used as a carrier and potassium/sodium chloride used as salting agents during the bismuth-phosphate process. (GE 1944 [Section C], GE 1951b, and HEW 1945)
Fluoride	Several compounds contained fluoride. The most widely used included lanthanum fluoride, which was used during the concentration operations of the bismuth-phosphate process, and ammonium silica fluoride, which was used as a cleaning and decontamination compound based on its ability to dissolve metals and fission products (GE 1944 [Section C], GE 1951b, HEW 1945).
Nitrate/nitrite	Several compounds contained nitrates/nitrites. The most widely used included sodium nitrite (a salting agent during the cladding removal), nitric acid (used throughout the bismuth-phosphate and uranium-recovery processes), and bismuth subnitrate (used to create the bismuth-Phosphate/plutonium solid during the first and second decontamination cycles (GE 1944 [Section C], GE 1951b, HEW 1945).

Table 1-8b. 200-TW-2 Operable Unit Final COC List. (3 pages)

Final COCs	Rationale for Inclusion
Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process (GE 1944 [Section C], HEW 1945).
Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in dissolving the fuel rods during the bismuth-phosphate process (GE 1944 [Section C], GE 1951b, HEW 1945). Other sulfate complexes were used as carriers for various metals.

Table 1-9 defines the ARARs and preliminary remediation goals (PRGs) for each of the COCs.

Table 1-9. List of Preliminary ARARs and PRGs. (2 pages)

COCs	Preliminary ARARs	PRGs
Radionuclides Inside the 200 Area Land-Use Boundary [a]		
Shallow zone (0 to 4.6 m [0 to 15 ft] bgs)	100 mrem/yr above background via industrial land-use scenario while under DOE control; 15 mrem/yr above background at the end of the exclusive-use period if DOE control is relinquished; 4 mrem/yr above background to groundwater; or no additional groundwater degradation.[b]	Contaminant-specific; RESRAD modeling[c]
Deep zone (>4.6 m [>15 ft] bgs)	4 mrem/yr above background to groundwater, or no additional groundwater degradation.[b]	MCLs, state and Federal ambient water quality control criteria; alternatively, site-specific modeling
Nonradiological Constituents Inside the 200 Area Land-Use Boundary		
Shallow zone (0 to 4.6 m [0 to 15 ft] bgs)	MTCA Method C	Chemical-specific
Deep zone (>4.6 m [>15 ft] bgs)	100 x groundwater (per MTCA)	Alternatively, site-specific modeling

Table 1-9. List of Preliminary ARARs and PRGs. (2 pages)

COCs	Preliminary ARARs	PRGs
TRU Waste Definition		
Any depth zone	Radioactive waste containing more than 100 nCi of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years except for (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the EPA, does not need the degree of isolation required by the 40 CFR 191 disposal regulations; or (3) waste that the U.S. Nuclear Regulatory Commission has approved on a case-by-case basis in accordance with 10 CFR 61.[d]	Contaminant-specific

[a] Based on *Final Hanford Comprehensive Land Use Plan Environmental Impact Statement* (DOE 1999) (see Figure 1-1)
[b] Radionuclide standards are not final and will be agreed upon in the ROD. A radionuclide standard of 25 mrem/yr above background has been proposed by the Washington State Department of Health (WDOH).
[c] The RESidual RADioactivity dose model (RESRAD) use has been used for similar waste sites and will be used as a minimum for direct exposure. If more appropriate models are developed, they will be evaluated for use.
[d] Working definition of TRU waste as stated in DOE O 435.1.
bgs = below ground surface
MCL = maximum contamination level

Table 1-10 lists the general exposure scenarios.

Table 1-10. General Exposure Scenarios. (2 pages)

Scenario No.	General Exposure Scenario Description
1	Industrial land-use scenario (inside the 200 Area land-use boundary)[a]: The source of contamination in the 200-TW-1 and 200-TW-2 OUs is the liquid effluent disposed to the waste sites. The release mechanism is direct radiation exposure to occupational workers in the vicinity of the waste sites (although shielded by stabilizing cover). Ingestion and inhalation of surface or subsurface soils in an occupational scenario does not represent a substantial exposure due to waste site surface stabilization and the limited soil ingestion and inhalation anticipated during excavation activities in an industrial setting (use of dust control measures limits exposures). Downward migration of mobile constituents into the groundwater would not affect occupational workers, as their drinking water source would not be the underlying aquifers. However, the protection of groundwater is a requirement and must be addressed by evaluating potential future impacts.

Table 1-10. General Exposure Scenarios. (2 pages)

Scenario No.	General Exposure Scenario Description
	The exposure time is divided into time spent inside and outside an industrial facility: • Building occupancy: 8 hours/day x 0.6 (building occupancy factor), 5 days/week, 50 weeks/yr, for 20 years (of a 75-year lifetime). • Outdoor exposure: 8 hours/day x 0.4 (outdoor exposure factor), 5 days/week, 50 weeks/yr, for 20 years (of a 75-year lifetime). In addition, the building occupancy exposure includes a factor of 0.4 to reduce the ingested dust component due to building ventilation system filtration. Biota that may be exposed to contaminants is these OUs will be addressed through a more Hanford Site-wide evaluation. Remedial actions to address human health concerns will also serve to protect biota.

[a] The *Final Hanford Comprehensive Land Use Plan Environmental Impact Statement* (DOE 1999) (see Figure 1-1) identifies the actual land use within the 200 Area land-use boundary as industrial (exclusive) and would center mainly around waste management activities.

Table 1-11 provides the regulatory milestones and regulatory drivers associated with this project.

Table 1-11. Regulatory Milestones.

Milestone	Due Date	Regulatory Driver
M-13-23	August 31, 2000	Tri-Party Agreement milestone to submit Draft A work plan for 200-TW-1 OU
M-13-24	August 31, 2000	Tri-Party Agreement milestone to submit Draft A work plan for 200-TW-2 OU

The project milestones and their drivers are listed in Table 1-12.

Table 1-12. Project Milestones.

Milestone	Due Date	Driver
Internal DQO workshop	April 13, 2000	DQO schedule
RL and Office of River Protection integration workshop	January 19, 2000	
External DQO workshop	April 27, 2000	
Issue DQO summary report	June 2000	DQO process documentation

Table 1-13 combines the relevant background information into a concise statement of the problem to be resolved.

Table 1-13. Preliminary Conceptual Contaminant Distribution Model Discussion and Concise Statement of the Problem. (2 pages)

Preliminary Conceptual Contaminant Distribution Model[a]:

The waste streams associated with the URP and the scavenging processes at U Plant and the B and T tank farms were discharged to the 200-TW-1 OU waste sites. The streams contained radionuclides and chemicals associated with the URP and scavenging processes, including fission products, actinides, and cyanide. Immobile contaminants accumulated in the sediments over time, and the mobile contaminants may have reached the groundwater. A number of cribs in the OU were sampled as part of the 200-BP-01 RI conducted in 1991 through 1992. Data from this investigation indicated a zone of higher contamination extending up to 30 m (100 ft) below the bottom of the cribs and trenches. Contamination continued below this zone but decreased with depth. More mobile contaminants were distributed throughout the soil column and are present at residual concentrations. Volatile organics were not a major part of the processes associated with 200-TW-1 OU waste sites. With the exception of TBP, no volatile organics are expected in the vadose zone. Because of the volume of liquid and contaminants received by the 200-TW-1 OU waste sites, groundwater impacts are generally assumed. Groundwater monitoring has indicated chemical and radionuclide constituents in the groundwater beneath the waste sites; however, contributions from individual waste sites have not been evaluated. While significant data exist for the BY cribs, which are representative of sites in the OU, limited chemical and radiological data are available for the other 200-TW-1 OU sites.

The liquid effluents associated with the plutonium recovery process at B and T Plants were discharged to the 200-TW-2 OU waste sites. These effluents contained radionuclides and chemicals associated with the bismuth-phosphate and lanthanum fluoride processes, including fission products, actinides, and nitrate. Immobile contaminants accumulated in the soils below the release point over time, while the mobile contaminants may have reached groundwater. Geophysical logging of boreholes in the vicinity of the waste sites provided the basis for the preliminary conceptual contaminant distribution model.

While the construction of the sites differs, the contamination distribution tends to follow a pattern of elevated contamination levels at and immediately below the bottom of the waste site and decreasing contamination with depth. More mobile contaminants were distributed through the soil column and are expected to be present at residual concentrations. For the reverse well, effluents were injected into the soils column and groundwater through casing perforations. Contamination extends outward from the casing in a plume that decreases in contamination with distance from the discharge point. The contamination plume affects both the vadose zone (from the top of the perforations to the water table) and the groundwater.

Volatile organics were not a part of the processes associated with 200-TW-2 OU waste sites. No volatile organics are expected in the vadose zone. Because of the volume of liquid and contaminants received by the 200-TW-2 OU waste sites, groundwater impacts are generally assumed. Groundwater monitoring has indicated chemical and radionuclide constituents in the groundwater beneath the waste sites; however, contributions from individual waste sites have not been evaluated. With the exception of the 216-B-5 reverse well, limited chemical and radiological data are available for the waste group (this is considered to be a data gap for the OU).

Figures 1-7 through 1-12 graphically present the preliminary conceptual contaminant distribution models for each of the representative waste sites. Each of these waste sites is analogous to other sites in the OUs.

Table 1-13. Preliminary Conceptual Contaminant Distribution Model Discussion and Concise Statement of the Problem. (2 pages)

DQO Approach:

The DQO process for the 200-TW-1 and 200-TW-2 OUs is being performed to determine if representative sites in these OUs have been contaminated to levels that require remedial action.

The outcome of the characterization being developed in this DQO process for the representative sites will be applied to the other analogous sites. A SAP will be developed after completion of the DQO process, which specifies the sampling and analyses to be performed for characterization of the five representative sites.

All of the waste sites associated with these OUs are located within the 200 Area land-use boundary line and will be evaluated on the basis of future industrial uses.

Problem Statement:

The problem is to determine contaminant concentrations and physical parameters in the representative sites to support evaluation of remedial alternatives and remedial decision making in the FS and to verify or refine the conceptual contaminant distribution models.

[a] The preliminary conceptual contaminant distribution model will become the conceptual contaminant distribution model after acceptance of this DQO summary report and will then be applied to the project work plan.

A data gap was identified during the DQO for the B/C cribs and trenches (i.e., sites 200-E-14, 216-B-14 through 216-B-34, and 216-B-52) because the physical property data that exist are of low quality compared to data for other areas. While none of these sites were identified as representative sites, an evaluation of this data gap was conducted. The evaluation showed that sites in this area received significantly less effluent volume than the corresponding pore volume in the vadose zone beneath the sites (see the waste site grouping report [DOE-RL 1997]). The geophysical logging data for the 100-B/C Area also show similar contaminant distribution as identified for the representative sites, especially for site 216-B-38. While the quality of the geologic data is limited, the available information is sufficient to support the RI/FS process. Additional data to support design and confirmation of the selected alternative will be collected during the confirmatory sampling phase as needed.

Figure 1-7. Conceptual Exposure Model for the 200-TW-1 and 200-TW-2 Operable Units.

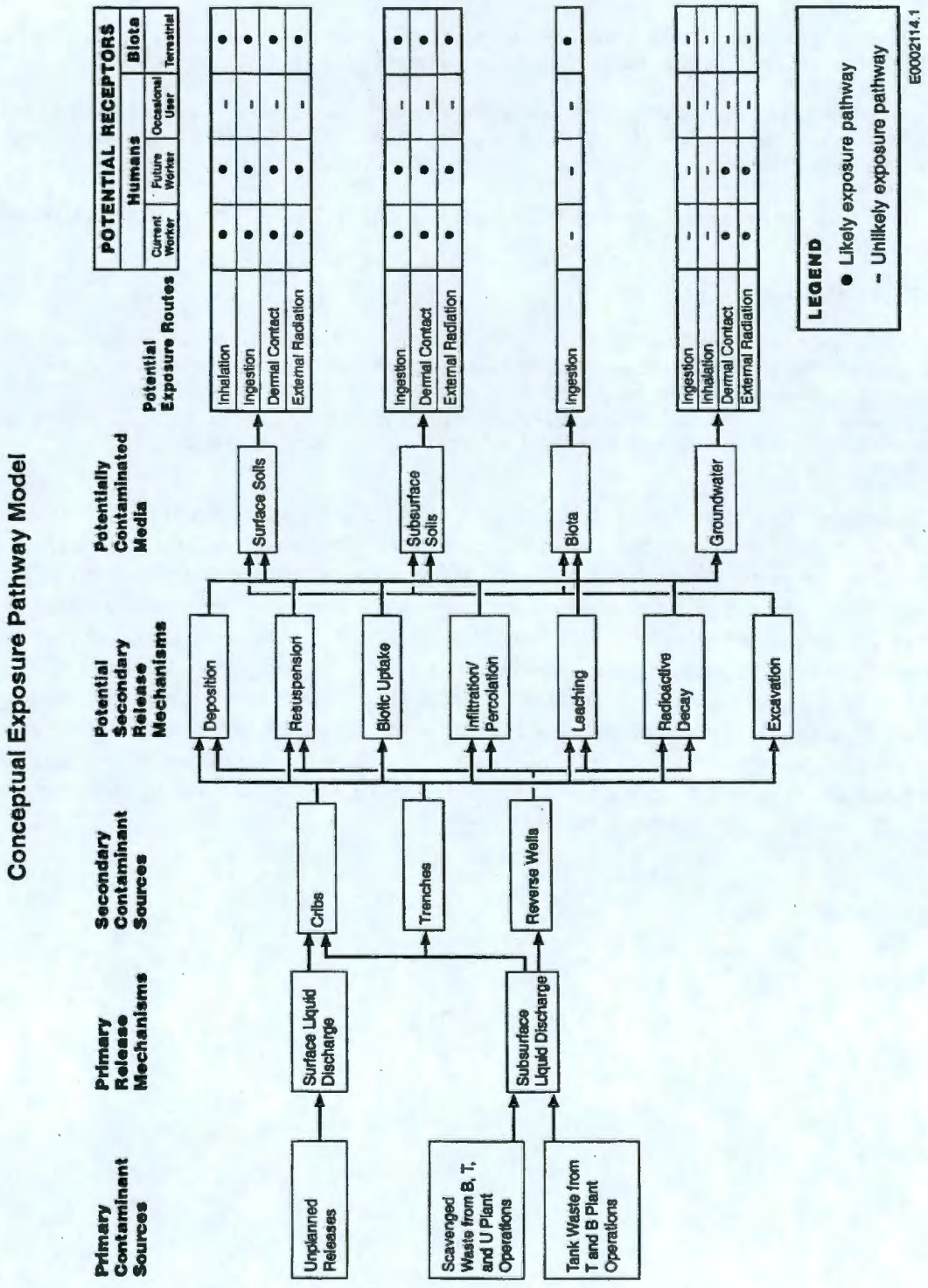
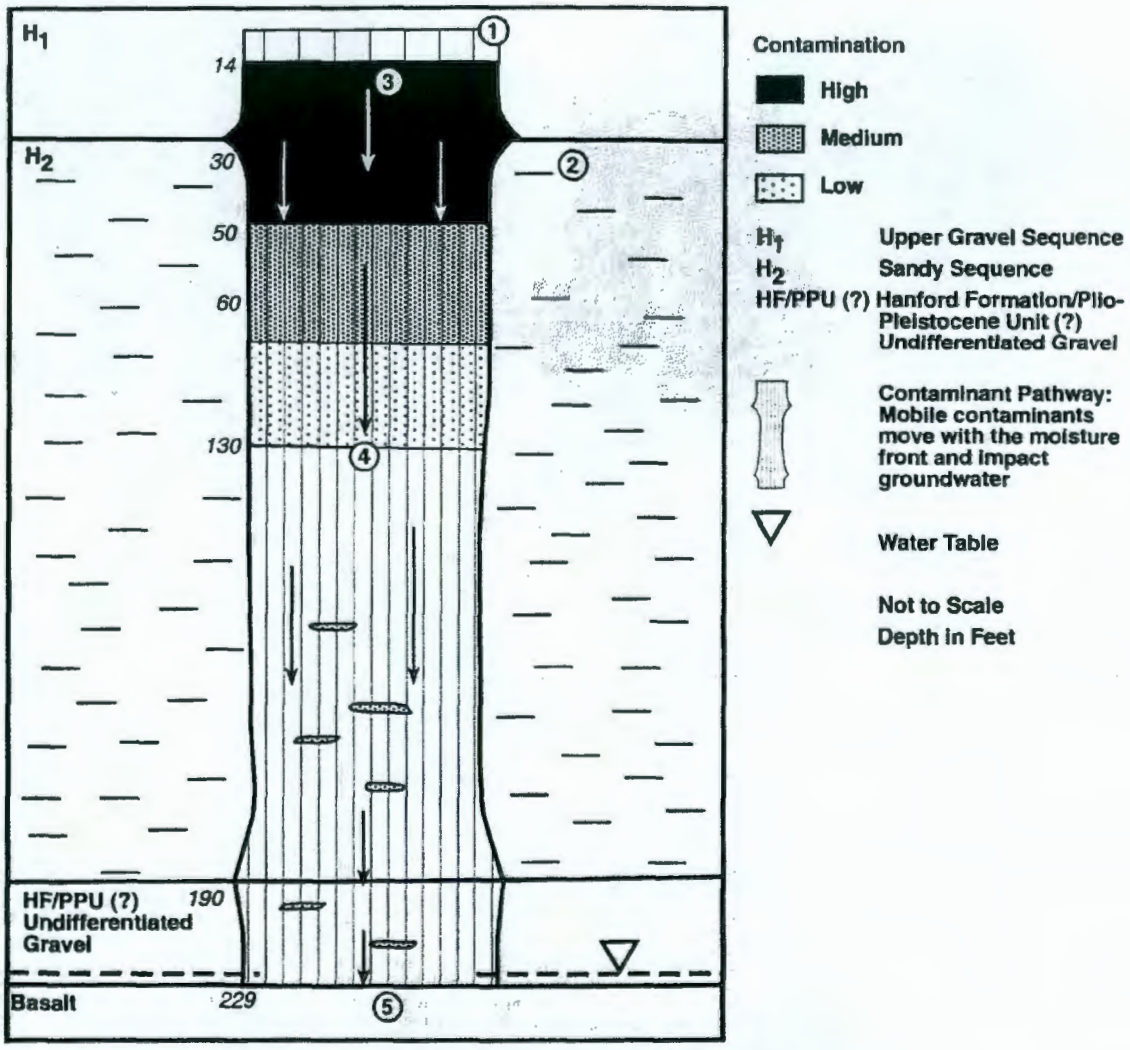


Figure 1-8. Preliminary Conceptual Contaminant Distribution Model for the 216-B-46 Crib.



① High salt, neutral/basic, low organic liquid waste containing cesium-137, strontium, cobalt-60, radium-226, and other contaminants from the single shell tank system were discharged to the crib in 1955. The crib received a total volume of 6,700,000L (1.8 million gal) of wastewater.

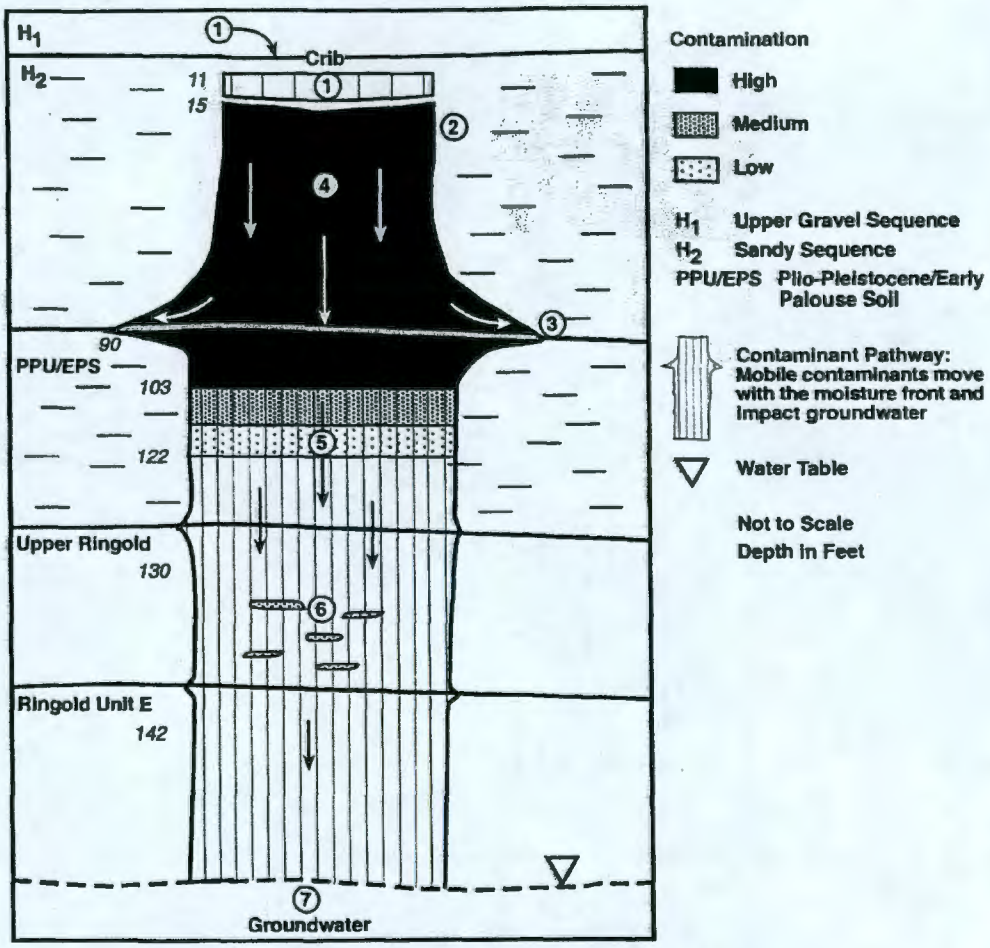
② Effluent and contaminants migrated vertically beneath the crib into H_1, H_2, and HF/PPU (?). There is little or no lateral spreading.

③ Immobile contaminants, such as cesium-137, sorb near the point of release in high concentration. However, enhanced mobility is indicated at this site because the major zone of contamination is approximately 30 ft. thick. Mobile contaminants such as cobalt-60 migrate with moisture front. Cobalt-60 mobility may be enhanced due to the presence of various ferrocyanide complexants.

④ Contaminant concentrations generally decreases with depth.

⑤ Wastewater and mobile contaminants impact groundwater.

Figure 1-9. Preliminary Conceptual Contaminant Distribution Model for the 216-T-26 Crib.



① High salt, neutral/basic, low organic radioactive liquid waste containing cesium-137, cobalt-60, plutonium-239/240, strontium-90 and other contaminants from the single shell tank system were discharged to the crib between 1955 and 1956. The crib received a total volume of 12,000,000L (3.2 million gal) of wastewater.

② Wastewater moved vertically down beneath the crib into H_2. There is little or no lateral spreading. However, the lack of spreading is not supported by borehole data.

③ Effluent and contaminants intersect the PPU/EPS approximately 90 ft. bgs. Lateral spreading of wastewater and contaminants may occur associated with this unit. If spreading occurs it is to the south based on the topography of the PPU/EPS.

④ Immobile contaminants, such as cesium-137, sorb to the crib and are distributed near the point of release in high concentrations. However, enhanced mobility is indicated at this site as the highly contaminated zone of cesium-137 is 78 ft. thick. Mobile contaminants such as cobalt-60 migrate with the moisture front.

⑤ Cobalt-60 mobility may be enhanced due to the presence of ferrocyanide complexants.

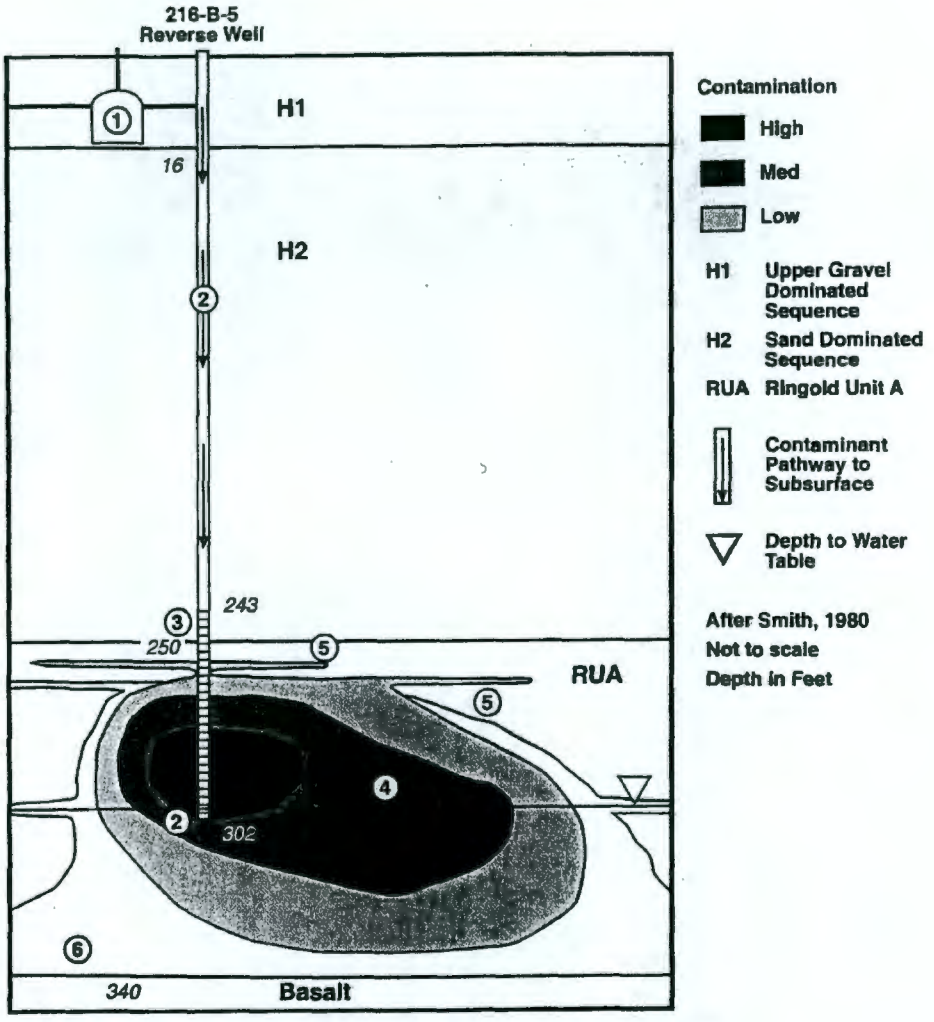
⑥ The activity of cesium-137 decreases with depth; it is not detected greater than 122 ft. bgs.

⑦ Antimony-125 and cobalt-60 were detected at low concentrations to a maximum depth of 140 ft.

Wastewater and mobile contaminants from the crib impact groundwater.

E9912036.3

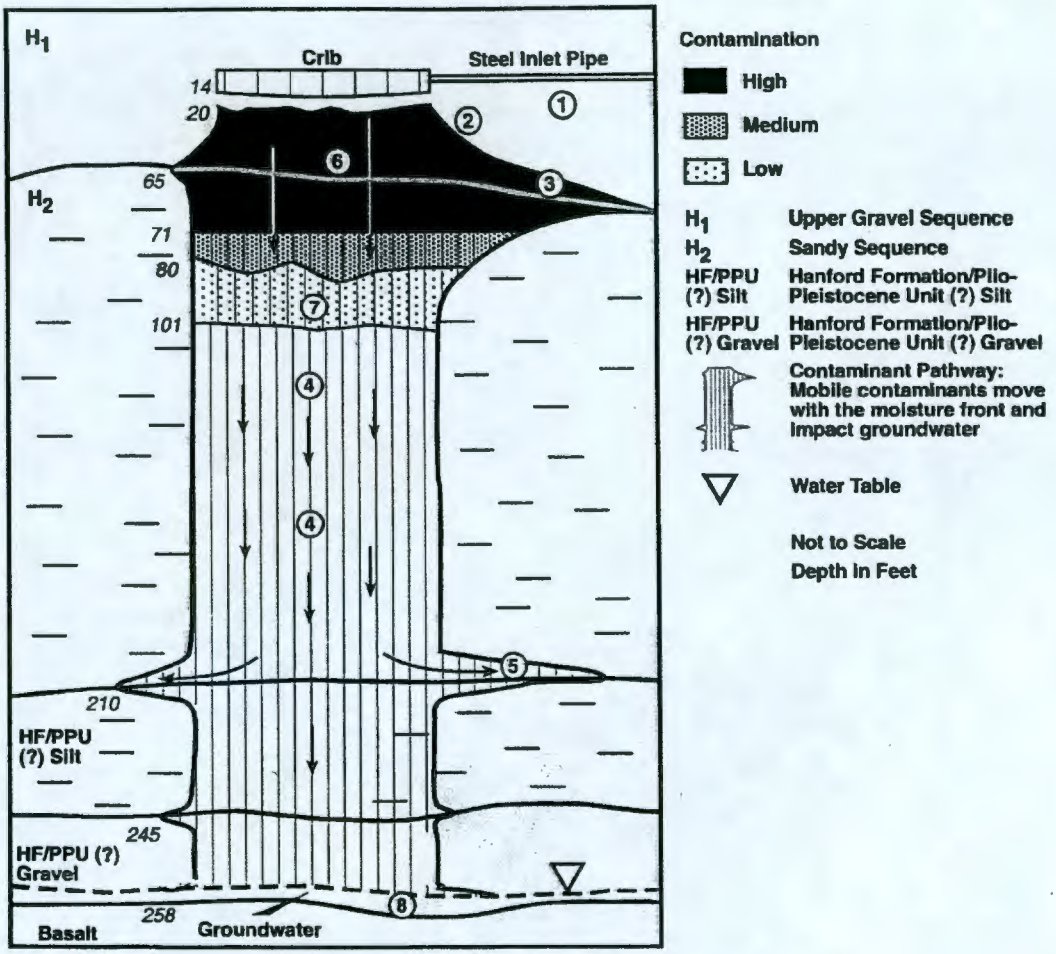
Figure 1-10. Preliminary Conceptual Contaminant Distribution Model for the 216-B-5 Reverse Well.



1. High salt, neutral/basic/low organic liquid waste with high quantities of plutonium 239/240. Cesium-137, and strontium-90 were discharged to the 216-B-361 settling tank. Contaminants precipitated/settled out in the tank.
2. Wastewater overflowed from the 216-B-361 settling tank and into the 216-B-5 reverse well through a 5 cm (2-inch) diameter stainless steel inlet pipe about 3.6 m (12 ft) bgs. The reverse well received approximately 30,600,000 L (8.1 million gal) of liquid waste. In addition, studies indicate that the well receive 4.3 kg of Pu.
3. Waste was released to the vadose zone and the water table through a perforated section of the reverse well extending 74 m - 92 m (242 ft - 302 ft) bgs. When the well was actively receiving waste, it penetrated 3 m (10 ft) into the aquifer.
4. Contaminant detected in the subsurface include: cesium-137, strontium-90, plutonium-239/240, and americium-241. The highest activities were detected near the well perforations. Activities generally decrease away from the well.
5. Cesium-137 preferentially sorbs into silt lenses intersected by perforated casing.
6. Plutonium-239/240 may occur in phosphate based mineral phase.
7. The vadose zone and groundwater has been impacted by operation of the 216-B-5 reverse well.

E9912004.1

Figure 1-11. Preliminary Conceptual Contaminant Distribution Model for the 216-B-7A and 216-B-7B Cribs.



① High salt, neutral/basic, low organic radioactive liquid waste containing Cs-137, plutonium, uranium, strontium-90 and other contaminants from the single shell tank farm system were discharged to the crib between 1946-1967. The cribs received a total volume of 43,600,000L (11,500,00 0 gal.) of wastewater.

② The wetting front and contaminants move vertically beneath the cribs into H_1. There is little or no lateral spreading.

③ Effluent and contaminants migrate laterally on top of H_2 which slopes to the northeast. Lateral spreading may extend at least 80 ft from the crib.

④ Contaminant flow and transport is mainly vertical beneath the crib in the lower half of H_2 and HF/PPU (?) Gravel.

⑤ Significant spreading of the wetting front may occur on top of the HF/PPU (?) Silt.

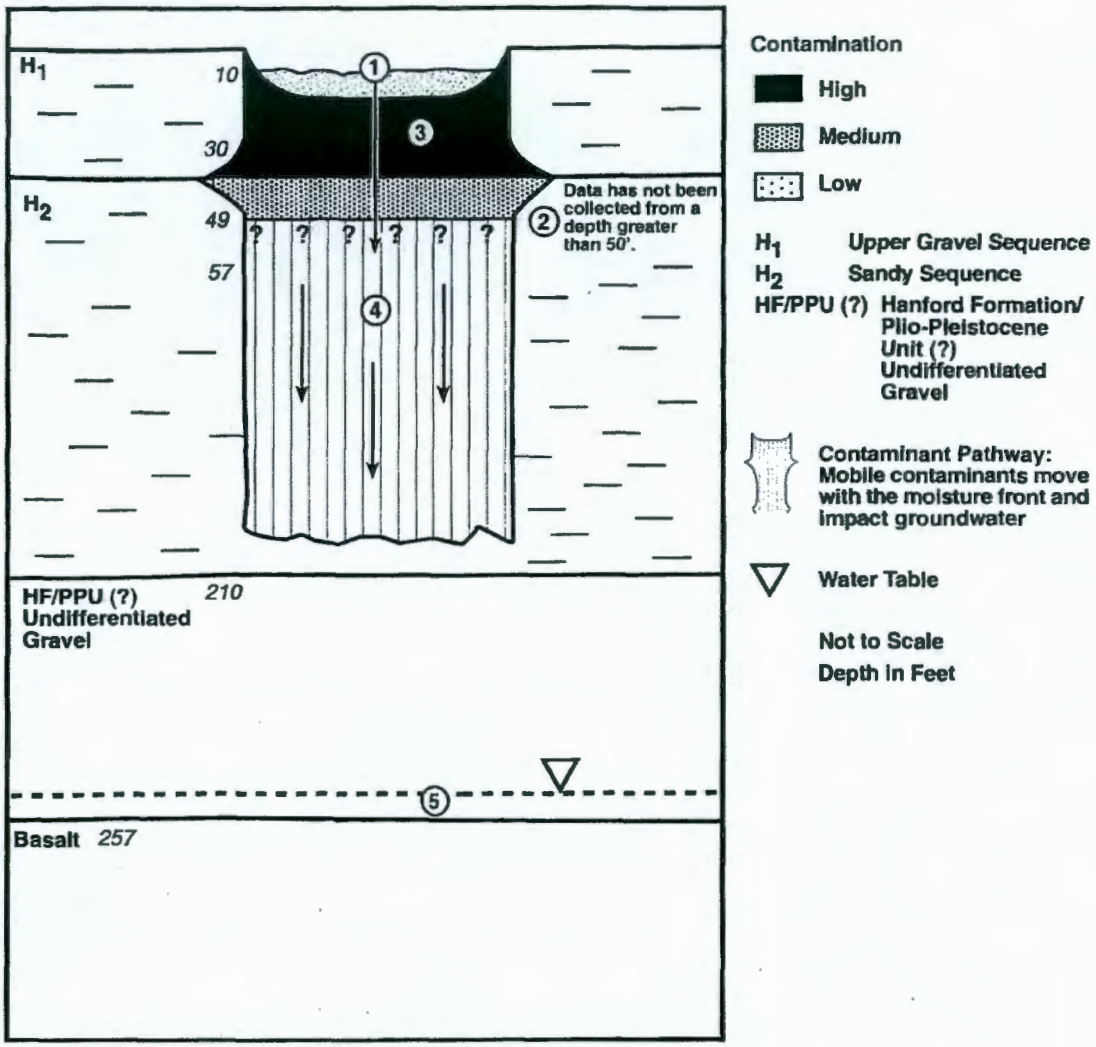
⑥ Immobile contaminants, such as cesium-137, sorb to the crib structure and are distributed near the point of release in high concentrations. However, enhanced mobility is indicated at this site as the highly contaminated zone of Cs-137 is approximately 50' thick. Mobile contaminants such as nitrate move with the moisture front.

⑦ The activity of cesium-137 decreases with depth. Contamination has not been detected greater than 101 ft. bgs in the vadose zone.

⑧ Wastewater and mobile contaminants from the crib impact groundwater.

E0004013.3

Figure 1-12. Preliminary Conceptual Contaminant Distribution Model for the 216-B-38 Trench.



(1) High salt, neutral, low organic radioactive waste containing cesium-137, plutonium-239/240, uranium, strontium-90 and other contaminants from the single shell tank farm system were discharged to the trench in 1954. The trench received a total volume of 1,430,000L (380,000 gal.) of wastewater.

(2) Effluent and contaminants were discharged into H_1. The wetting front and contaminants moved vertically down beneath the trench. There is little or no lateral spreading.

(3) Immobile contaminants, such as cesium-137, sorb to the bottom of the trench. The zone of greatest contamination is from the bottom of the trench to about 30 ft. bgs. Contaminant concentrations generally decreases with depth.

(4) The wetting front and mobile contaminants move downward beneath the crib. Data is not available to determine contaminant levels in this zone.

(5) During periods of active discharge, wastewater and mobile contaminants do not impact groundwater. Calculations of soil pore volume in DOE/RL-96-81 suggest that effluent volume does not exceed soil pore volume.

E0004013.1

2.0 STEP 2 -- IDENTIFY THE DECISION

The purpose of DQO Step 2 is to define the principal study questions (PSQs) that need to be resolved to address the problems identified in DQO Step 1 and the alternative actions that would result from resolution of the PSQs. The PSQs and alternative actions are then combined into decision statements that express a choice among alternative actions. Table 2-1 presents the task-specific PSQs, alternative actions, and resulting decision statements. This table also provides a qualitative assessment of the severity of the consequences of taking an alternative action if it is incorrect. This assessment takes into consideration human health and the environment (flora/fauna) and political, economic, and legal ramifications. The severity of the consequences is expressed as low, moderate, or severe.

Table 2-1. Summary of DQO Step 2 Information. (3 pages)

PSQ-AA #	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
Principal Study Question #1 – Do the contaminant concentrations in the vadose soils in the 200-TW-1 and 200-TW-2 OU representative waste sites exceed the TRU definition?[a]			
1-1	If the contaminant concentrations exceed the TRU definition, evaluate special remedial alternatives in a FS.	Special remedial alternatives for the waste sites will be unnecessarily developed during the FS. The remedial alternative will unnecessarily incorporate costly and difficult processes for handling TRU-contaminated soil.	Low for risk; risk would be overstated; actual risk would be lower. Moderate for cost.
1-2	If the contaminant concentrations do not exceed the TRU definition, evaluate conventional remedial action alternatives in a FS.	The FS and associated remedial action will not plan for special remedial alternatives necessary for handling TRU-contaminated soils. These soils might be incorrectly managed and disposed. Workers could be exposed to unacceptable levels of transuranics during remediation.	Moderate for risk; additional samples will be collected during the confirmatory sampling phase to confirm waste profiles.
Decision Statement #1 – Determine if the contaminant concentrations in the vadose soils in the 200-TW-1 and 200-TW-2 OU representative waste sites exceed the TRU definition and require special remedial action.			
Principal Study Question #2—Do the radionuclide concentrations in vadose soils in the 200-TW-1 and 200-TW-2 OU representative waste sites exceed the annual radiological exposure limits for human health protection under an industrial exposure scenario?[a]			
2-1	If the radionuclide concentrations in the vadose soils do not exceed the industrial exposure limits, evaluate the site for closure with no remedial action in a FS.	The site may inappropriately be closed without remedial action, increasing risks of potential exposure to workers and the environment.	Low; additional samples will be collected in the confirmatory sampling phase to support no action closures.

Table 2-1. Summary of DQO Step 2 Information. (3 pages)

PSQ-AA #	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
2-2	If the radionuclide concentrations in the vadose soils exceed the industrial exposure limits, evaluate the need for remedial action alternatives or evaluate a streamlined approach to site closure (e.g., add to an existing ROD) in a FS.	The site may be inappropriately remediated resulting in unnecessary expenditure of funds.	Low for risk; no risk to human health or environment. Low to moderate for cost depending on remedial action.
Decision Statement #2 – Determine if the vadose zone radionuclide concentrations in the 200-TW-1 and 200-TW-2 OU representative waste sites exceed the radiological exposure limits for human health protection under an industrial exposure scenario requiring evaluation in a FS.			
Principal Study Question #3 – Do the concentrations of nonradiological constituents in the vadose soils in the 200-TW-1 and 200-TW-2 OU representative waste sites exceed the nonradiological exposure limits for human health protection under an industrial exposure scenario?[a]			
3-1	If the nonradiological constituent concentrations in the vadose soils do not exceed the industrial exposure limits, evaluate the site for closure with no remedial action in a FS.	The site may inappropriately be closed without remedial action, increasing risks of potential exposure to workers and the environment.	Low; additional samples will be collected in the confirmatory sampling phase to support no action closures.
3-2	If the nonradiological constituent concentrations in the vadose soils exceed the industrial exposure limits, evaluate the need for remedial action alternatives or evaluate a streamlined approach to site closure (e.g., add to an existing ROD) in a FS.	The site may be inappropriately remediated resulting in unnecessary expenditure of funds.	Low for risk; no risk to human health or environment. Low to moderate for cost depending on remedial action.
Decision Statement #3 – Determine if vadose zone nonradiological constituent concentrations in the 200-TW-1 and 200-TW-2 OU representative waste sites exceed the nonradiological constituent exposure limits for human health protection under an industrial exposure scenario requiring evaluation in a FS.			
Principal Study Question #4 – Do the 200-TW-1 and 200-TW-2 OU conceptual contaminant distribution models properly reflect the physical characteristics and distribution of contaminants in the waste sites?			
4-1	If the conceptual contaminant distribution models reflect the actual distribution of contaminants and physical characteristics, use the models for remedial alternative selection and remedial action planning.	Inappropriate or inadequate remedial alternatives could be planned in the FS and implemented during the remedial action phase.	Low to moderate; additional sampling in confirmatory phase will limit consequences.

Table 2-1. Summary of DQO Step 2 Information. (3 pages)

PSQ-AA #	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
4-2	If the conceptual contaminant distribution models do not accurately reflect the distribution of contaminants and physical characteristics, revise the models prior to remedial alternative selection and remedial action planning.	The site may be inappropriately remediated resulting in unnecessary expenditure of funds.	Low; no risk to human health or the environment
Decision Statement #4 – Determine if the 200-TW-1 and 200-TW-2 OU conceptual contaminant distribution models represent the contaminant distribution conditions and physical characteristics in each waste site or if the models need to be refined.			

[a] Refer to Table 1-9 for scenario-specific ARARs and PRGs.

3.0 STEP 3 -- IDENTIFY THE INPUTS TO THE DECISION

The purpose of DQO Step 3 is to identify the types of data needed to resolve each of the decision statements identified in DQO Step 2. The data may already exist or may be derived from computational or surveying/sampling and analysis methods. Analytical performance requirements (e.g., practical quantitation limit [PQL], precision, and accuracy) are also provided in this step for any new data that need to be collected.

3.1 INFORMATION REQUIRED TO RESOLVE DECISION STATEMENTS

Table 3-1 specifies the information (data) required to resolve each of the decision statements identified in Table 2-1 and identifies whether the data already exist. For the data that are identified as existing, the source references for the data have been provided with a qualitative assessment as to whether or not the data are of sufficient quality to resolve the corresponding decision statement.

Table 3-1. Required Information and Reference Sources. (3 pages)

PSQ #	Required Information Category	Do Data Exist? Y//N	Source Reference	Are Available Data of Sufficient Quality and Quantity to Support RI/FS Process? (Y/N)					Are Additional Data Required to Support RI/FS Process? (Y/N)				
				B-46	T-26	B-5	B-7A/ B	B-38	B-46	T-26	B-5	B-7A /B	B-38
1, 2, and 4	Soil radiological data	Y	*Phase I Remedial Investigation Report for 200-BP-1 Operable Unit*, Vols. 1 and 2, DOE/RL-92-70, Rev. 0 (DOE-RL 1993c). Provides data summaries and results from extensive field investigation at BY cribs.	Y	[a]	[a]	[a]	[a]	N	[b]	[b]	[b]	[b]
			216-B-5 Reverse Well Characterization Study, RHO-ST-37 (Smith 1980). Provides radiological soil and groundwater data from seven boreholes in the vicinity of the reverse well.	[a]	[a]	Y	[a]	[a]	[b]	[b]	N	[b]	[b]
			T Plant Source Aggregate Area Management Study Report, DOE/RL-91-61, Rev. 0 (DOE-RL 1993b). Provides summary of existing data for sites associated with T Plant.	[a]	N	[a]	[a]	[a]	[b]	Y	[b]	[b]	[b]
			B Plant Source Aggregate Area Management Study Report, DOE/RL-92-05, Rev. 0 (DOE-RL 1993a). Provides summary of existing data for sites associated with B Plant.	N	[a]	N	N	N	N	[a]	N	Y	Y
			Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells, ARH-ST-156 (Fecht et al. 1977). Provides scintillation logs with gross gamma readings for boreholes in the vicinity of the waste sites.	[a]	N	[a]	N	[a]	[b]	Y	[b]	Y	[b]
			PNLATLAS database, which provides borehole geophysical logging data for gamma-emitting radionuclides.	[a]	N	[a]	N	N	[b]	Y	[b]	Y	Y

Table 3-1. Required Information and Reference Sources. (3 pages)

PSQ #	Required Information Category	Do Data Exist? Y//N	Source Reference	Are Available Data of Sufficient Quality and Quantity to Support RI/FS Process? (Y/N)					Are Additional Data Required to Support RI/FS Process? (Y/N)				
				B-46	T-26	B-5	B-7A/ B	B-38	B-46	T-26	B-5	B-7A /B	B-38
			Waste Site Grouping for 200 Areas Soil Investigations, DOE/RL-96-81, Rev. 0 (DOE-RL 1997). Provides existing information for the wastes sent to these OUs.	N	N	N	N	N	N	Y	N	Y	Y
3 and 4	Soil nonradiological sample data	Y	*Phase I Remedial Investigation Report for 200-BP-1 Operable Unit*, Vols. 1 and 2, DOE/RL-92-70, Rev. 0 (DOE-RL 1993c). Provides data summaries and results from extensive field investigation at BY cribs.	Y	[a]	[a]	[a]	[a]	N	[b]	N[c]	[b]	[b]
N/A	Groundwater data	Y	See Section 1-4.	Groundwater data cannot be used to validate a vadose zone preliminary conceptual contaminant distribution model.									
All	Physical properties moisture content, particle size distribution, and lithology	Y	*Hydrogeologic Model for the 200-East Groundwater Aggregate Area*, WHC-SD-EN-TI-014, Rev. 0 (WHC 1992a). Presents site-specific data for 200 East Area that can be used to calculate soil density, hydraulic conductivity, and porosity.	[a]	N	[a]	[a]	[a]	[b]	Y	[b]	[b]	[b]
			Hydrogeologic Model for the 200-West Groundwater Aggregate Area, WHC-SD-EN-TI-290, Rev. 0 (WHC 1992b). Presents site-specific data for 200 West Area that can be used to calculate soil density, hydraulic conductivity, and porosity.	Y	[a]	Y	N	N	N	[b]	N	Y	Y

Table 3-1. Required Information and Reference Sources. (3 pages)

PSQ #	Required Information Category	Do Data Exist? Y/N	Source Reference	Are Available Data of Sufficient Quality and Quantity to Support RI/FS Process? (Y/N)					Are Additional Data Required to Support RI/FS Process? (Y/N)				
				B-46	T-26	B-5	B-7A/B	B-38	B-46	T-26	B-5	B-7A/B	B-38
All	Distribution coefficients	Y	*Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, PNNL-11800 (PNNL 1998). Provides 200 Area distribution coefficients for various waste stream types and Hanford soils.	Y	Y	Y	Y	Y	N	N	N	N	N
			Geochemical Data Package for the Hanford Immobilized Low-Activity Tank Waste Performance Assessment (ILAW PA), PNNL-13037, Rev. 1 (Kaplan and Serne 2000). Provides 200 Area distribution coefficients for various waste stream types and Hanford soils.	Y	Y	Y	Y	Y	N	N	N	N	N
All	RESRAD input data	Y	*Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0*, ANL-EAD-LD-2 (ANL 1993). Input parameters are defined in this manual that can be determined based on existing information or RESRAD defaults.	N/A	N/A	N/A	N/A	N/A	N	Y	N	Y	Y

[a] Document does not pertain to this waste site; no site-specific information included for the site.

[b] Decision on additional data is irrelevant for the document as no site-specific information is included for the site.

[c] Radiological data from Smith (1980) are assumed adequate to support the RI/FS process at 216-B-5 reverse well; nonradiological data from 216-B-7A and 216-B7-B Cribs will be applied to the RI/FS process for this site because the 216-B-7A and 216-B-7B Cribs received the same waste stream as the 216-B-5 reverse well.

N/A = not applicable

3.2 BASIS FOR SETTING THE PRELIMINARY ACTION LEVEL

The preliminary action level is the threshold value that provides the criterion for choosing between alternative actions. Table 3-2 identifies the basis (i.e., regulatory threshold or risk-based) for establishing the preliminary action level for each of the COCs. The numerical value for the action level is defined in DQO Step 5.

Table 3-2. Basis for Setting Preliminary Action Level.

DS #	COCs	Basis for Setting Preliminary Action Level
1	TRU-contaminated soils	DOE's definition for TRU waste (DOE O 435.1).
2	Radiological COCs	Radiological lookup values for shallow zone soils based on RESRAD analyses for the applicable scenarios. Deep zone lookup values TBD.
3	Nonradiological COCs	MTCA Method C cleanup levels with contaminant-specific variations.
4	Radiological and nonradiological COCs	Preliminary action levels do not apply for preliminary conceptual contaminant distribution model evaluation. This is a judgmental assessment.

DS = decision statement
N/A = not applicable
TBD = to be determined in a vadose zone transport model co-selection process.

3.3 COMPUTATIONAL AND SURVEY/ANALYTICAL METHODS

Table 3-3 identifies the decision statements where existing data either do not exist or are of insufficient quality to resolve the decision statements. For these decision statements, Table 3-3 presents computational and/or surveying/sampling methods that could be used to obtain the required data.

Table 3-3. Information Required to Resolve the Decision Statements.[a]

DS #	Remedial Investigation Variable	Required Data	Computational Methods	Survey/Analytical Methods
1, 2, and 4	Concentrations of radiological COCs in vadose zone soils	Alpha, beta, and gamma COC concentrations in soils for evaluation against ARARs an PRGs. Location data (depth and lateral extent of COCs within waste site boundaries).	RESRAD – analytical modeling method for human health dose assessment. TBD – analytical modeling through vadose zone to groundwater.	Field screening with radiological detection equipment. Geophysical borehole logging with downhole radiological detectors. Soil sampling and laboratory analysis.
3 and 4	Concentrations of nonradiological COCs in vadose zone soils	Nonradiological (e.g., inorganic metals and anions, and SVOCs) COC concentrations in soils for evaluation against ARARs and PRGs. Location data (depth and lateral extent of COCs within waste site boundaries).	Risk assessment. TBD – analytical modeling through vadose zone to groundwater.	Soil sampling and laboratory analysis.
All	Physical properties in vadose zone soils	Moisture content, bulk density, particle size distribution	Direct comparison to existing models to determine conductivity.	Soil sampling and laboratory analysis.

[a] See Table 3-5 for additional information.
SVOC = semi-volatile organic compound
TBD = to be determined

Table 3-4 presents details on the computational methods identified in Table 3-3. These details include the source and/or author of the computational method and information on how the method could be applied to this study.

Table 3-4. Details on Identified Computational Methods.

DS #	Computational Method	Source/ Author	Application to Study	Satisfy Input Req't?
1 and 2	RESRAD	Argonne National Laboratory	RESRAD will be used to estimate direct human radiation exposure to account for radioactive decay.	Yes
1, 2, and 3	TBD	TBD	Estimates direct human radiation exposures and the migration of all contaminants (radiological and nonradiological) to groundwater for indirect exposure estimates. If mobile contaminants are present, then a vadose zone transport model will be needed and typically requires site-specific geohydrologic soil properties such as hydraulic conductivity, moisture, etc.	TBD

TBD = to be determined in a vadose zone transport model co-selection process.

Table 3-5 identifies each of the survey and/or analytical methods that may be used to provide the required information needed to resolve each of the decision statements. The possible limitations associated with each of these methods are also provided.

Table 3-5. Potentially Appropriate Survey and/or Analytical Methods. (3 pages)

Media	Remediation Variable	Potentially Appropriate Survey/ Analytical Method	Possible Limitations
Field Screening			
Fine-grained materials, structures	Site location; underground structures or interferences	GPR	GPR is a radar-reflection surface geophysical survey technique that detects contrasts in di-electric constants in the below-grade environments from the surface. Requires subjective interpretation of the reflected signals. Lack of reflective below-grade surfaces or the presence of interfering matrices can complicate or invalidate the findings. The presence of nearby buildings and utilities can interfere with reflected signals. Fines (e.g., clay and heavy fly ash) can act as a reflector to the radar signal.
		EMI	EMI is a surface geophysical survey technique that measures electrical conductivity in below-grade soils based on detected changes in electrical fields. The results of EMI are generally used to support the interpretation of GPR surveys. Nearby buildings and utilities can cause interferences.

Table 3-5. Potentially Appropriate Survey and/or Analytical Methods. (3 pages)

Media	Remediation Variable	Potentially Appropriate Survey/ Analytical Method	Possible Limitations
Vadose zone soils	Gross and isotopic gamma emissions	Cone penetrometer; NaI detector logging	A closed-end rod is pushed into the soil to the desired depth. A small-diameter NaI detector (or other suitable detector) is used to log the gross gamma response with depth. The cone penetrometer is not effective in cobbly or rocky soils.
	Gross and isotopic gamma emissions	Direct push; NaI detector logging	A small-diameter casing is pushed into the soil to the desired depth. A small-diameter NaI detector (or other suitable detector) is used to log the gamma response with depth. Direct-push methods (e.g., Geoprobe) may be ineffective in cobbly or rocky soils.
	Gamma emissions from fission products, Am-241, Pu-239, and Np-237	Borehole SGL with HPGe detector	Gamma-ray logging provides the concentration profiles of gamma-emitting radionuclides such as Am-241, Pu-239, and many fission products in a borehole environment. It is considered by some to be more accurate than sampling and laboratory assay because the assay is performed in situ with less disturbance of the sample, there is higher vertical spatial resolution, and the sample size is much larger. This method may also be more economical than traditional sampling and analysis. This method does not assess radionuclides or daughter products that do not emit gamma rays. The gamma energies from these isotopes are at the low end of the spectrum, which results in high numerical minimum detectable activities and possible matrix effects from other isotopes. This technique requires the use of a single casing (installed by drilling or driving) in contact with the soil formation.
	Neutron emissions from plutonium	Borehole passive neutron logging	Passive neutron logging provides indication of the presence of neutron-emitting isotopes. Because of the very low incidence of spontaneous Pu fission and alpha-N reactions, the passive neutron profile is orders of magnitude lower than the gamma emissions.
	Active neutron emissions from transuranics	Borehole passive/active neutron-logging methods	This technique uses source materials or generators to release neutrons into the soil formation. Passive detectors measure the response to the neutron flux as a means of detecting specific transuranic constituents. Although neutron activation methods have been developed, they are not expected to be useful for this initial characterization effort. At present, these techniques are too expensive and time consuming, and logistical problems are associated with the handling of intense sources or generators.
	Vertical moisture profile	Borehole neutron-neutron moisture logging	N-N moisture logs can be used to determine current moisture content profiles of the subsurface through new or existing boreholes. The moisture profiles are often directly correlated to contaminant concentrations, sediment grain size, composition, or subsurface structural features. For this project, the moisture profile may be useful for helping determine the location of contamination and/or the location of the ditch and establish geologic conditions to support contaminant fate and transport modeling. It may also be correlated to reflections identified in ground-probing radar surveys.

Table 3-5. Potentially Appropriate Survey and/or Analytical Methods. (3 pages)

Media	Remediation Variable	Potentially Appropriate Survey/ Analytical Method	Possible Limitations
Laboratory Samples			
Vadose zone soils	All COCs and physical properties	Laboratory analysis	Highly contaminated samples require use of onsite laboratories, with associated impacts (e.g., high cost, reduced analyte lists, matrix effects, degraded detection limits, and long turnaround times). Lower contamination levels allow use of offsite laboratories, avoiding these limitations. Physical property analysis will include bulk density, moisture content, and particle size distribution.

EMI = electromagnetic imaging
GPR = ground-penetrating radar
HPGe = high-purity germanium
NaI = sodium iodide
SGL = spectral gamma logging

3.4 ANALYTICAL PERFORMANCE REQUIREMENTS

Table 3-6 defines the analytical performance requirements for the data that need to be collected to resolve each of the decision statements. These performance requirements include the PQL and the precision and accuracy requirements for each of the COCs.

Table 3-6. Analytical Performance Requirements – Shallow and Deep Zone Soils. (3 pages)

COCs	CAS #	Preliminary Action Level[a]			Name/Analytical Technology	Target Required Quantitation Limits				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		RR[b] (pCi/g)	C/I[b] (pCi/g)	GW Protection[b,h] (pCi/g)		Water[c] Low Activity (pCi/L)(	Water[c] High Activity pCi/L)	Soil-Other Low Activity (pCi/g)	Soil-Other High Activity (pCi/g)				
Americium-241	14596-10-2	31	210	TBD	Americium isotopic – AEA	1	400	1	4,000	+-20%	70-130%	+-35%	70-130%
Carbon-14	14762-75-5	5.2[g]	33,100	TBD	Carbon-14 - liquid scintillation	200	N/A	50	N/A	+-20%	70-130%	+-35%	70-130%
Cesium-137	10045-97-3	6.2	25	TBD	GEA	15	200	0.1	2,000	+-20%	70-130%	+-35%	70-130%
Cobalt-60	10198-40-0	1.4	5.2	TBD	GEA	25	200	0.05	2,000	+-20%	70-130%	+-35%	70-130%
Europium-152	14683-23-9	3.3	12	TBD	GEA	50	200	0.1	2,000	+-20%	70-130%	+-35%	70-130%
Europium-154	15585-10-1	3	11	TBD	GEA	50	200	0.1	2,000	+-20%	70-130%	+-35%	70-130%
Europium-155	14391-16-3	125	449	TBD	GEA	50	200	0.1	2,000	+-20%	70-130%	+-35%	70-130%
Hydrogen-3	10028-17-8	359[g]	14,200	TBD	Tritium – liquid scintillation	400	400	400	400	+-20%	70-130%	+-35%	70-130%
Neptunium-237	13994-20-2	2.5	62.2	TBD	Neptunium-237 - AEA	1	N/A	1	8,000	+-20%	70-130%	+-35%	70-130%
Nickel-63	13981-37-8	4,026	3,008,000	TBD	Nickel-63 - liquid scintillation	15	N/A	30	N/A	+-20%	70-130%	+-35%	70-130%
Plutonium-238	13981-16-3	37	483	TBD	Plutonium isotopic – AEA	1	130	1	1,300	+-20%	70-130%	+-35%	70-130%
Plutonium-239/240	Pu-239/240	34	243	TBD	Plutonium isotopic – AEA	1	130	1	1,300	+-20%	70-130%	+-35%	70-130%
Strontium-90	Rad-Sr	4.5	2,500	TBD	Total radioactive strontium - GPC	2	80	1	800	+-20%	70-130%	+-35%	70-130%
Technetium-99	14133-76-7	5.7[g]	410,000	TBD	Technetium-99 - liquid scintillation	15	400	15	4,000	+-20%	70-130%	+-35%	70-130%
Thorium-232	TH-232	1	5.1	TBD	Thorium isotopic - AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	+-20%	70-130%	+-35%	70-130%
Uranium-234	13966-29-5	160	1200	TBD	Uranium isotopic - AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	+-20%	70-130%	+-35%	70-130%
Uranium-235	15117-96-1	26	100	TBD	Uranium isotopic - AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	+-20%	70-130%	+-35%	70-130%
Uranium-238	U-238	85	420	TBD	Uranium isotopic - AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	+-20%	70-130%	+-35%	70-130%

Table 3-6. Analytical Performance Requirements – Shallow and Deep Zone Soils. (3 pages)

COCs	CAS #	Preliminary Action Level[a]			Name/Analytical Technology	Target Required Quantitation Limits				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		Method B[l] (mg/kg)	Method C[m] (mg/kg)	GW Protection[n] (mg/kg)		Water[c] Low Conc. (mg/L)	Water[c] High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)				
Metals													
Cadmium	7440-43-9	80	3,500	0.5	Metals - 6010 - ICP	0.005	0.01	0.5	1	[f]	[f]	[f]	[f]
Cadmium	7440-43-9	80	3,500	0.5	Metals - 6010[d] – ICP (trace)	0.005	N/A	0.5	N/A	[f]	[f]	[f]	[f]
Chromium (total)	7440-47-3	80,000[j]	Unlimited[j]	10	Metals - 6010 - ICP	0.01	0.01	1	2	[f]	[f]	[f]	[f]
Chromium (total)	7440-47-3	80,000[j]	Unlimited[j]	10	Metals - 6010 – ICP (trace)	0.01	N/A	1	N/A	[f]	[f]	[f]	[f]
Chromium VI	18540-29-9	400	17,500	8	Chromium (hex) - 7196 - colorimetric	0.01	4	0.5	200	[f]	[f]	[f]	[f]
Copper	7440-50-8	2,960	130,000	59.2	Metals - 6010 - ICP	0.025	0.025	2.5	2.5	[f]	[f]	[f]	[f]
Lead	7439-92-1	200[i]	1,000[i]	N/A	Metals - 6010 - ICP	0.1	0.2	10	20	[f]	[f]	[f]	[f]
Lead	7439-92-1	353	1,000[i]	1.5	Metals - 6010 - ICP(trace)	0.01	N/A	1	N/A	[f]	[f]	[f]	[f]
Mercury	7439-97-6	24	1,050	0.2	Mercury - 7470 - CVAA	0.0005	0.005	N/A	N/A	[f]	[f]	[f]	[f]
Mercury	7439-97-6	24	1,050	0.2	Mercury - 7471 - CVAA	N/A	N/A	0.2	0.2	[f]	[f]	[f]	[f]
Nickel	7440-02-0	1,600[k]	70,000[k]	32	Metals - 6010 - ICP	0.04	0.04	4	4	[f]	[f]	[f]	[f]
Silver	7440-22-4	400	17,500	8	Metals - 6010 - ICP	0.02	0.02	2	2	[f]	[f]	[f]	[f]
Silver	7440-22-4	400	17,500	8	Metals - 6010 - ICP(trace)	0.005	N/A	0.5	N/A	[f]	[f]	[f]	[f]
Uranium (total)	7440-61-1	240[k]	10,500[k]	2	Uranium total - kinetic phosphorescence analysis	0.0001	0.02	1	0.2	+-20%	70-130%	+-35%	70-130%
Inorganics													
Ammonia/ ammonium	7664-41-7	Unlimited	Unlimited	27,200	Ammonia - 350.N[e]	0.05	800	0.5	8,000	[f]	[f]	[f]	[f]
Chloride	16887-00-6	25,000[a]	25,000[a]	25,000	Anions - 9056 - IC	0.2	5	2	5	[f]	[f]	[f]	[f]
Cyanide	57-12-5	1,600	70,000	20	Total cyanide - 9010 - colorimetric	0.005	0.005	0.5	0.5	[f]	[f]	[f]	[f]
Fluoride	16984-48-8	4,800	210,000	96	Anions - 9056 - IC	0.5	5	5	5	[f]	[f]	[f]	[f]
Nitrate	14797-55-8	128,000	Unlimited	4,400	Anions - 9056 - IC	0.25	10	2.5	40	[f]	[f]	[f]	[f]
Nitrite	14797-65-0	8,000	350,000	160	Anions - 9056 - IC	0.25	15	2.5	20	[f]	[f]	[f]	[f]
Phosphate	14265-44-2	N/A	N/A	None	Anions - 9056 - IC	0.5	15	5	40	[f]	[f]	[f]	[f]
Sulfate	14808-79-8	25,000[a]	25,000[a]	25,000	Anions - 9056 - IC	0.5	15	5	40	[f]	[f]	[f]	[f]

Table 3-6. Analytical Performance Requirements – Shallow and Deep Zone Soils. (3 pages)

COCs	CAS #	Preliminary Action Level[a]			Name/Analytical Technology	Target Required Quantitation Limits				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		Method B[l] (mg/kg)	Method C[m] (mg/kg)	GW Protection[n] (mg/kg)		Water[c] Low Conc. (mg/L)	Water[c] High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)				
Organics													
Kerosene (normal paraffin hydrocarbons)	8008-20-6	200[l]	200[l]	200[l]	Non-halogenated VOA - 8015M - GC modified for hydrocarbons	0.5	0.5	5	5	[f]	[f]	[f]	[f]
Tributyl phosphate	126-73-8	None	None	None	Semi-volatiles - 8270 – GCMS	0.1	0.5	3.3	5	[f]	[f]	[f]	[f]
Total organic carbon	TOC	N/A	N/A	None	TOC - 9060-combustion	1	1	100	100	+-20%	70-130%	+-35%	70-130%

[a] The preliminary action level is the regulatory or risk-based value used to determine appropriate analytical requirements (e.g., detection limits). Remedial action levels will be proposed in the FS, finalized in the ROD, and will drive remediation of the sites.
[b] RR = rural residential, C/I = commercial industrial, GW = groundwater protection radionuclide values from WDOH's *Hanford Guidance for Radiological Cleanup* (WDOH 1983). Radionuclide values are calculated using parameters from WDOH guidance.
[c] Water values for sampling quality control (e.g., equipment blanks/rinses) or drainable liquid (if recovered).
[d] All four-digit numbers refer to *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods* (EPA 1986).
[e] From *Methods of Analysis of Water and Waste* (EPA 1983).
[f] Precision and accuracy requirements as identified and defined in the referenced EPA procedures.
[g] If quantitation to action level lower than nominal reliable detection level is required, prior notification/concurrence with the laboratory will be required to address special low-level detection limits.
[h] The "100 times groundwater" rule does not apply to residual radionuclide contaminants. For radionuclides, groundwater protection is demonstrated through technical evaluation using RESRAD (DOE-RL 1998).
[i] This value is based upon MTCA Method A values.
[j] Value based upon chromium (III) MTCA soil concentrations.
[k] Value based upon nickel or uranium soluble salts value.
[l] MTCA Method B soil values for direct exposure.
[m] MTCA Method C industrial soil values for direct exposure.
[n] MTCA Method B soil values for protection of groundwater.

AEA = alpha energy analysis
CVAA = cold vapor atomic absorption
GC = gas chromatograph
GCMS = gas chromatograph/mass spectrometry
GPC = gas proportional counter
IC = ion chromatography
ICPMS = inductively coupled plasma mass spectrometer
N/A = not applicable
TOC = total organic carbon
VOA = volatile organic analysis

4.0 STEP 4 -- DEFINE THE BOUNDARIES OF THE STUDY

4.1 OBJECTIVE

The primary objective of DQO Step 4 is for the DQO team to identify the spatial, temporal, and practical constraints on the sampling design and to consider the consequences. This objective (in terms of the spatial, temporal, and practical constraints) ensures that the sampling design results in the collection of data that accurately reflect the true condition of the site and/or populations being studied.

4.2 WORKSHEETS FOR STEP 4 -- DEFINE THE BOUNDARIES OF THE STUDY

Table 4-1 defines the population of interest to clarify what the samples are intended to represent. The characteristics that define the population of interest are also identified.

Table 4-1. Characteristics that Define the Population of Interest.

DS #	Population of Interest	Characteristics
Cribs and Specific Retention Trenches		
All	Vadose zone soils beneath the representative waste sites	Concentrations of transuranic radionuclides, other radionuclides, metals, and limited organic constituents; physical properties including moisture content, bulk density, and grain size distribution

Table 4-2 defines the spatial boundaries of the decision and the domain or geographic area (or volume) within which all decisions must apply (in some cases, this may be defined by the OU). The domain is a region distinctly marked by some physical features (i.e., volume, length, width, and boundary).

Table 4-2. Geographic Boundaries of the Investigation.

DS #	Geographic Boundaries of the Investigation
All	The geographic boundaries for the investigation are the boundaries of the individual representative waste sites.

When appropriate, the population is divided into strata that have relatively homogeneous characteristics. The DQO team must systematically evaluate process knowledge, historical data, and plant configurations to present evidence of a logic that supports alignment of the population

into strata with homogeneous characteristics. Table 4-3 identifies the strata with homogeneous characteristics.

Table 4-3. Zones with Homogeneous Characteristics.

DS #	Population of Interest	*Zone*	Homogeneous Characteristic Logic
Cribs and Specific Retention Trenches			
2, 3, and 4	Vadose zone soils beneath the representative waste sites	Clean or very low concentration stabilizing fill over waste site	Not expected to be contaminated except in the 216-B-7A and 216-B-7B Cribs, where a UPR was consolidated over the cribs and then stabilized with clean fill. Fill will be field-screened for contamination at all sites during characterization activities.
All		Highest contaminant concentration layer[a]	The particulates and high distribution coefficient contaminants were sorbed and/or filtered out of the liquid flow via the soils at the bottom of the excavated crib/trench. This zone is expected to contain the highest concentrations of contaminants and to have decreasing concentrations with depth. May also contain residual concentrations of mobile constituents.
2, 3, and 4		Moderate to low contaminant concentration layer[a]	A moderate concentration layer was formed immediately beneath the expected high concentration layer. In this zone, finer particulates and moderate distribution coefficient contaminants from the liquid waste streams were filtered and sorbed. High volumes of disposed liquids may have carried some immobile constituents into this zone, and residual concentrations of mobile constituents may also be present. This zone is expected to have decreasing concentrations with depth as more immobile constituents filter and sorb out with the passing of the wetting front.[b]
2, 3, and 4		Low contaminant concentration layer[a]	This zone is expected to contain low concentrations of mobile contaminants from the source to the groundwater table. Concentrations are expected to remain fairly constant through the impacted zone because the majority of the contaminants have been flushed through the system, leaving residual concentrations.

[a] The thickness is not specified.
[b] The wetted front may have reached groundwater for crib sites. It is not known if groundwater was impacted by the discharges in the trench sites.

The temporal boundaries of the decision are defined in Table 4-4.

Table 4-4. Temporal Boundaries of the Investigation.

DS #	Time Frame	When to Collect Data
Field Screening		
All	0 to 5 years[a] after issuance of the SAP	Avoid extreme hot/cold months due to impacts on worker efficiency and equipment effectiveness. Inclement weather may impact sample quality.
Laboratory Samples		
All	0 to 5 years[a] after issuance of the SAP	Avoid extreme hot/cold months and inclement weather that have potential to impact sample integrity and soil sampling operations.

[a] Time frame is approximate and may be impacted by changing priorities, budgets, and approval of the work plan.

4.3 SCALE OF DECISION MAKING

Table 4-5 defines the scale of decision making for each decision statement. The scale of decision making is defined as the smallest, most appropriate subsets of the population (sub-population) for which decisions will be made based on the spatial or temporal boundaries of the area under investigation.

Table 4-5. Scale of Decision Making.

DS #	Population of Interest	Geographic Boundary	Temporal Boundary		Spatial Scale of Decision Making
			Time Frame[a]	When to Collect Data	
All	Vadose zone soils beneath the representative waste sites	Boundaries of the individual representative waste sites: 216-T-26 Crib, 216-B-7A&B Cribs, and 216-B-38 Trench	0 to 5 years after issuance of SAP	Avoid extreme hot/cold months and inclement weather that have potential to impact sample integrity and soil sampling operations.	Vadose soils

[a] Time frame is approximate and may be impacted by changing priorities, budgets, and approval of the work plan.

The zones of homogeneous characteristics in Table 4-3 identify strata within the representative waste site. However, the spatial scale of decision making is the vadose zone soils from the ground surface to the water table. The data support remedial decision making that will consider the vertical distribution of contaminants throughout the entire vadose zone.

4.4 PRACTICAL CONSTRAINTS

Table 4-6 identifies all of the practical constraints that may impact the data collection effort. These constraints include physical barriers, difficult sample matrices, high radiation areas, or any other condition that will need to be taken into consideration in the design and scheduling of the sampling program.

Table 4-6. Practical Constraints on Data Collection.

Boreholes may not obtain sufficient volumes of sample media if the sampled zone is 0.6-m (2-ft) thick or less. Advancement of borehole casing may smear contamination downhole.
The soils in the vadose zone are expected to be typical Hanford Site soils. These soils should be easily recognizable and should not pose unusual sampling problems.
Other Constraints:
Health and safety constraints may be imposed during characterization sampling to ensure that as low as reasonably achievable issues are properly addressed when sampling potentially transuranic-contaminated and other radiologically contaminated soils.
Laboratory constraints are expected when analyzing soil samples with high contaminant concentrations. Soil samples in this category would be analyzed in an onsite laboratory. Impacts are expected in cost, degradation of detection limits, and possible reduction in the analyte lists. Extreme weather conditions may also limit or shut down field screening operations.
The 216-B-7A and 216-B-7B Cribs are currently marked with cave-in potential signs. This may limit the use of a drill rig directly over the crib and will be investigated or may require special equipment to allow drilling through the crib. This will be evaluated through the health and safety analysis and pre-job planning to support the characterization effort.
Statistical sampling will not be cost-effective or necessary for RI characterization; therefore, sampling is biased towards areas of elevated contamination levels.

5.0 STEP 5 -- DEVELOP A DECISION RULE

The purpose of DQO Step 5 is initially to define the statistical parameter of interest (i.e., maximum, mean, or 95% upper confidence level [UCL]) that will be used for comparison against the action level. The statistical parameter of interest specifies the characteristic or attribute that a decision maker would like to know about the population. The preliminary action level for each of the COCs is also identified in DQO Step 5. When this is established, a decision rule is developed for each decision statement in the form of an "IF...THEN..." statement that incorporates the parameter of interest, the scale of decision making, the preliminary action level, and the alternative actions that would result from resolution of the decision. Note that the scale of decision making and alternative actions were identified earlier in DQO Steps 4 and 2, respectively.

5.1 INPUTS NEEDED TO DEVELOP DECISION RULES

Tables 5-1, 5-2, and 5-3 present the information needed to formulate the decision rules in Section 5.2. This information includes the decision statements and alternative actions identified in DQO Step 2, the scale of decision making identified in DQO Step 4, and the statistical parameters of interest and preliminary action levels for each of the COCs.

Table 5-1. Decision Statements.

DS #	Decision Statement
1	Determine if the contaminant concentrations in the vadose soils in the 200-TW-1 and 200-TW-2 OU representative waste sites exceed the TRU definition and require special remedial action.
2	Determine if the vadose zone radionuclide concentrations in the 200-TW-1 and 200-TW-2 OU representative waste sites exceed the radiological exposure limits for human health protection under an industrial exposure scenario requiring evaluation in a FS.
3	Determine if vadose zone nonradiological constituent concentrations in the 200-TW-1 and 200-TW-2 OU representative waste sites exceed the nonradiological constituent exposure limits for human health protection under an industrial exposure scenario requiring evaluation in a FS.
4	Determine if the 200-TW-1 and 200-TW-2 OU conceptual contaminant distribution models represent the contaminant distribution conditions and physical characteristics in each waste site or if the models need to be refined.

Table 5-2. Inputs Needed to Develop Decision Rules.

DS #	COCs	Parameter of Interest	Scale of Decision Making	Preliminary Action Levels
1	Transuranic radionuclides	Soil sampling; detected values	Vadose zone soils	100 nCi/g
2	Radionuclides			RESRAD lookup values and TBD through other modeling; radionuclide concentrations equating to a dose limit of 100 mrem/yr
3	Nonradiological constituents			MTCA and other regulatory levels (identified in Table 3-6)
4	Radiological and nonradiological constituents and physical properties			N/A

N/A = not applicable
TBD = to be determined

The alternative actions identified in DQO Step 2 are summarized in Table 5-3.

Table 5-3. Alternative Actions.

PSQ #	AA #	Alternative Actions
1	1	If the contaminant concentrations exceed the TRU definition, evaluate special remedial alternatives in a FS.
	2	If the contaminant concentrations do not exceed the TRU definition, evaluate conventional remedial action alternatives in a FS.
2	1	If the radionuclide concentrations in the vadose soils do not exceed the industrial exposure limits, evaluate the site for closure with no remedial action in a FS.
	2	If the radionuclide concentrations in the vadose soils exceed the industrial exposure limits, evaluate the need for remedial action alternatives or evaluate a streamlined approach to site closure (e.g., add to an existing ROD) in a FS.
3	1	If the nonradiological constituent concentrations in the vadose soils do not exceed the industrial exposure limits, evaluate the site for closure with no remedial action in a FS.
	2	If the nonradiological constituent concentrations in the vadose soils exceed the industrial exposure limits, evaluate the need for remedial action alternatives or evaluate a streamlined approach to site closure (e.g., add to an existing ROD) in a FS.
4	1	If the conceptual contaminant distribution models reflect the actual distribution of contaminants and physical characteristics, use the models for remedial alternative selection and remedial action planning.
	2	If the conceptual contaminant distribution models do not accurately reflect the distribution of contaminants and physical characteristics, revise the models prior to remedial alternative selection and remedial action planning.

5.2 DECISION RULES

The output of DQO Step 5 and the previous DQO steps are combined into "IF...THEN" decision rules that incorporate the parameter of interest, the scale of decision making, the action level, and the actions that would result from resolution of the decision. The decision rules are listed in Table 5-4.

Table 5-4. Decision Rules. (2 pages)

DR #	Decision Rule
1	If the detected soil sampling results in the 200-TW-1 and 200-TW-2 OU representative waste site vadose soils exceed the TRU definition of 100 nCi/g, then analyze the nonradiological constituents and evaluate the need for special remedial action alternatives in a FS. If the detected soil sampling results in the 200-TW-1 and 200-TW-2 OU representative waste site vadose soils do not exceed the TRU definition of 100 nCi/g, then evaluate the other radiological constituents and the nonradiological constituents in accordance with DR #2.
2	If the analytical results of the soils samples collected from the 200-TW-1 and 200-TW-2 OU waste sites meet all of the following conditions: • The RESRAD analysis of maximum detected soil sampling results for the radiological COCs in the 200-TW-1 and 200-TW-2 OU representative waste site vadose soils do not exceed the annual exposure limits for human health protection. • The fate and transport analysis (TBD) of the maximum detected soil sampling results for the radiological COCs in the 200-TW-1 and 200-TW-2 OU representative waste site vadose soils do not exceed the annual exposure limits for protection of groundwater. • The analytical results of the 200-TW-1 and 200-TW-2 OU representative waste sites indicate that detected values do not exceed the respective nonradiological COC preliminary action levels for direct exposure. • The analytical results of the 200-TW-1 and 200-TW-2 OU representative waste site vadose soils indicate that the detected values do not exceed the respective nonradiological COC preliminary action levels for protection of groundwater. Then evaluate for site closure with no remedial action. If any of these conditions are not met, then evaluate the need for conventional remedial action alternatives within an FS, or evaluate a streamlined approach to site closure to be applied administratively via an existing ROD.

Table 5-4. Decision Rules. (2 pages)

DR #	Decision Rule
3	If the detected values indicate that the contamination distribution and physical characteristics in the 200-TW-1 and 200-TW-2 OU waste sites do not differ significantly from the preliminary conceptual contaminant distribution model, then the preliminary conceptual contaminant distribution model will not be revised prior to use for remedial decision making or remedial action planning. If the detected values indicate that the contamination distribution and physical properties in the 200-TW-1 and 200-TW-2 OU waste sites differ significantly from the preliminary conceptual contaminant distribution model, then the preliminary conceptual contaminant distribution model will be revised prior to use for remedial decision making or remedial action planning.

[a] The use of the term "remedial action" is used collectively to refer to one of the alternatives described in the project objectives discussion. The selection of the appropriate alternative action is beyond the scope of this DQO summary report.

DR = decision rule

TBD = to be determined

6.0 STEP 6 -- SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

Because analytical data can only estimate the true condition of the site under investigation, decisions that are made based on measurement data could potentially be in error (i.e., decision error). For this reason, the primary objective of DQO Step 6 is to determine which decision statements (if any) requires a statistically based sample design. For those decision statements requiring a statistically based sample design, DQO Step 6 defines tolerable limits on the probability of making a decision error.

6.1 STATISTICAL VERSUS NON-STATISTICAL SAMPLING DESIGN

Table 6-1 provides a summary of the information used to support the selection between a statistical versus a non-statistical sampling design for each decision statement. The factors that were taken into consideration in making this selection included the time frame over which each of the decision statements applies, the qualitative consequences of an inadequate sampling design, and the accessibility of the site if resampling is required.

Table 6-1. Statistical Versus Non-Statistical Sampling Design.

DS #	Time Frame (Years)	Qualitative Consequences of Inadequate Sampling Design (Low/ Moderate/Severe)	Resampling Access After RI (Accessible/ Inaccessible)	Proposed Sampling Design (Statistical/ Non-Statistical)
1, 2, 3, and 4	0 to 5	Low	Accessible	Non-statistical

6.2 NON-STATISTICAL DESIGNS

A biased (or focused) sampling approach, which targets the maximum potential contamination within a waste site, is considered appropriate for the waste sites in the 200-TW-1 and 200-TW-2 OUs. Contaminant distributions are expected to follow relatively predictable patterns based on process knowledge and existing environmental data.

For those decision statements to be resolved using a non-statistical design, there is no need to define the "gray region" or the tolerable limits on decision error because these only apply to statistical designs. The nature of the waste sites to be investigated in the RI supports the use of focused sampling, as identified in *Washington State Department of Ecology Toxics Cleanup Program Guidance on Sampling and Data Analysis Methods* (Ecology 1995). This guidance document defines "focused sampling" as selective sampling of areas where potential or

suspected soil contamination can reliably be expected to be found if a release of a hazardous substance has occurred. The relatively small crib structures to be investigated released contaminants in a point-source fashion. Contaminants released through a small crib would likely impact the soil immediately beneath the crib with minimal lateral spread; therefore, focusing the RI sampling through the crib will ensure collection of the area of greatest impact associated with the discharge. Even though the 216-B-38 Trench is larger than the cribs identified for RI, the trench is still a relatively small site. Additional efforts may be needed to determine the worst-case location for the borehole within the trench, which will provide additional data on gamma-emitting radionuclides to support the focused sampling regime.

7.0 STEP 7 -- OPTIMIZE THE DESIGN

7.1 PURPOSE

The purpose of DQO Step 7 is to identify the most resource-effective design for generating data to support decisions while maintaining the desired degree of precision and accuracy. When determining an optimal design, the following activities should be performed:

- Review the DQO outputs from the previous DQO steps and the existing environmental data.
- Develop general data collection design alternatives.
- Select the sampling design (e.g., techniques, locations, or numbers/volumes) that most cost effectively satisfies the project's goals.
- Document the operational details and theoretical assumptions of the selected design.

7.2 WORKSHEETS FOR STEP 7 -- OPTIMIZE THE DESIGN

Table 7-1 identifies information in relation to determining the data collection design.

Table 7-1. Determine Data Collection Design.

Decision	Statistical	Non-Statistical	Rationale
All	N/A	Non-statistical sampling design	Judgmental data collection design is applicable to investigation as preliminary data suggest that the highest levels of contamination are located relative to release points or the bottom of waste sites. Relative size of waste sites present a point-source-type disposal, focusing the area of investigation to the distribution of contaminants with depth. Consequences of erroneous decisions are not severe. Characterization sampling results will be verified by confirmatory sampling of analogous sites during the confirmatory and remedial design phase.

N/A = not applicable

Table 7-2 is used to develop general data collection design alternatives. If the data collection design for a given decision will be non-statistical, determine what type of non-statistical design is appropriate (i.e., haphazard or judgmental).

Table 7-2. Determine Non-Statistical Sampling Design.

DR #	Haphazard	Judgmental
All	None	Professional judgmental sampling design is indicated.

The data collection design alternatives for this project are described in Table 7-3.

Table 7-3. Methods for Collection of Data at Depth. (2 pages)

Method	Description
Trenching or test pit sampling	Excavation with backhoe or excavator. This technique provides grab samples taken directly from the soil column (approximate 0.3-m [1-ft] intervals) or from the excavator bucket. Because this technique creates a trench, direct inspection of the exposed soil column is possible. This method is not well suited for soils contaminated with alpha-emitting radionuclides because of direct exposure to personnel, equipment, wind, and weather.
Cone penetrometer or direct-push sampling	A closed-end rod is pushed into the soil to the desired depth, where a removable tip is displaced and a small volume of soil is retrieved. Due to the small volume of soil retrieved, multiple samples would be required to meet sample volume requirements for a large analyte list. The cone penetrometer and other direct-push methods are easily stopped by cobbles, rocks, or other features in the soil column. The resulting hole can be geophysically logged, providing information on gamma-emitting radionuclides and moisture content.
Auger drilling and sampling	Grab samples may be collected from the auger fitting during drilling, or split tube samples may be collected with the aid of hollow-stem auger "flights." To achieve laboratory analysis sample volume needs for large analytical lists, a 0.6-m (2-ft) core sample from a 13-cm (5-in.)-diameter sampler is typically needed. Running a sample tube down the hollow center of the flight retrieves split tube samples. This method is not well suited to drilling in soils contaminated with alpha-emitting radionuclides because of contamination control limitations. The auger split-spoon samples are typically 6 cm (2.5 in.) in diameter.
Cable tool drilling and sampling	This slow drilling method is particularly useful in highly contaminated areas because potential contamination releases can be more easily controlled. This drilling method allows collection of grab samples from the drive barrel or split-spoon. To achieve adequate laboratory analysis sample volumes for large analytical lists, a 0.6-m (2-ft)-long core sample from a 13-cm (5-in.)-diameter sampler is typically needed. DOE-owned, controlled cable tool rigs are available onsite for use in highly contaminated areas. In alpha-contaminated soils, significant contamination controls are required.
Diesel hammer drilling	The diesel hammer is a dual-string, reverse-air circulation drilling method. The potential impacts of this drilling method include degraded sample quality and increased contaminant release potential. Because of the introduction of air to the sample media, affects on analytical results for volatile organics and increased potential for dust result from this technique.

Table 7-3. Methods for Collection of Data at Depth. (2 pages)

Method	Description
Sonic drilling and sampling	Sonic drilling can quickly advance either well casings or sample tubes. Samples are retrieved similar to split-spoon sample collection during a cable tool operation. To achieve adequate laboratory analysis sample volumes, a 0.6-m (2-ft)-long core sample is typically needed from a 13-cm (5-in.)-diameter sampler. Sonic drilling is much faster than cable tool drilling, but the technique generates a significant amount of heat, which can alter samples (e.g., liberate volatile organics from the sampled soils) and the surrounding formation. In alpha contaminated soils, significant contamination controls are required and may be difficult to implement because of the nature of the equipment and operations.
Air rotary drilling and sampling	Air rotary drilling is much faster than other drilling techniques. Grab samples and split-spoon samples may be taken using this method. In addition, most rotary drill rigs can be configured to collect core samples. To achieve adequate laboratory analysis sample volumes, a 0.6-m (2-ft)-long core sample is typically needed from a 13-cm (5-in.)-diameter sampler. This technique may introduce air into the soil, potentially altering the sample quality and formation moisture levels.

The design options are evaluated based on cost and ability to meet the DQO constraints. The results of the trade-off analyses should lead to one of two outcomes: (1) the selection of a design that most efficiently meets all of the DQO constraints, or (2) the modification of one or more outputs from DQO Steps 1 through 6 and the selection of a design that meets the new constraints.

The key features of the selected design are then documented, including (for example) the following:

- Maps outlining sample locations, strata, and inaccessible areas
- Directions for selecting sample locations, if the selection is not necessary or appropriate at this time
- Order in which samples should be collected (if important)
- Stopping rules
- Special sample collection methods
- Special analytical methods.

7.3 SAMPLING OBJECTIVES

The initial step in the DQO effort concluded that the historical characterization data available for the 216-B-46 Crib met the data quality needs for the RI/FS process. In addition, historical radiological data for the 216-B-5 reverse well are sufficient for remedial action decision making

in terms of radiological contamination. The characterization objectives identified in Section 1.3 result in the following characterization goals:

- Determine the types and concentrations of chemical and radiological constituents with depth at worst-case locations in the 216-T-26 Crib, 216-B-7A and 216-B-7B Cribs, and 216-B-38 Trench.
- Determine the presence and location of transuranic (above the TRU definition) materials associated with the worst-case locations at the 216-T-26 Crib, 216-B-7A and 216-B-7B Cribs, and 216-B-38 Trench.
- Obtain characterization data for the chemical constituents in the 216-B-7A and 216-B-7B Cribs to support evaluation of chemical constituents at the 216-B-5 reverse well.
- Geophysically log planned boreholes.
- Analyze soils for physical properties to support modeling efforts.

7.4 SAMPLING DESIGN

7.4.1 Summary of Sampling Activities

A summary of the sampling activities is presented in Table 7-4.

Table 7-4. Key Features of the 200-TW-1 and 200-TW-2 Sampling Design. (5 pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
216-B-46 Crib		
Existing data are sufficient to support the RI/FS decision process. No additional data are required; no sampling activities are planned.		
216-T-26 Crib		
Surface geophysical surveys (GPR and EMI)	Perform GPR and/or EMI over the general area of crib location.	Surface geophysical surveys used to locate crib and subsurface features. Geophysics techniques are expected to distinctly identify the crib location.

Table 7-4. Key Features of the 200-TW-1 and 200-TW-2 Sampling Design. (5 pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Borehole characterization	Install one vadose borehole within the crib boundaries at the location with the highest contamination potential, avoiding subsurface structures. Location will be based upon interpretation of the surface geophysical results. Borehole will be drilled to the water table. Collect soil samples at the top of the crib (if soil is available), within the crib (if soil is available), at the bottom of the crib at the gravel/soil interface (approximately 4.6 m [15 ft] bgs), at 6.1 m, 7.6 m, 9.1 m, 12.2 m, 21.4 m, 27.4 m, 45.8 m, and 61 m [20 ft, 25 ft, 30 ft, 40 ft, 70 ft, 90 ft, 150 ft, and 200 ft] bgs and at the water table (approximately 67.7 m [222 ft]). Collect bulk density and grain-size distribution samples at major changes in lithology. Moisture samples will be collected along with the other physical samples.	Drill borehole to allow soil sampling with depth and to support geophysical logging with spectral gamma and neutron moisture tools. Soil samples will be used to determine type and concentration of COCs beneath the crib in the vadose zone. Sampling provides data for remedial action decision making, to confirm the preliminary conceptual contaminant distribution model, and to support numerical modeling efforts. Soil physical properties (e.g., moisture content, grain-size distribution, and bulk density) will be used to support numerical modeling.
	Perform borehole spectral logging from the surface to groundwater.	SGL logging will be performed to verify gamma-emitting contamination and to refine the preliminary conceptual contaminant distribution model. Cesium-137 will be the main target isotope for the SGL because of its prevalence and ease in identification; other gamma-emitting radionuclides may be detected.
	Perform neutron moisture logging from surface to groundwater.	Collect soil moisture data to support numerical modeling.
Borehole spectral logging in existing wells	Perform borehole spectral logging and neutron moisture logging in accessible boreholes and groundwater wells near the cribs. BHI well status records indicate that the following wells are accessible and will provide useful information on contaminant distribution: • 299-W11-70 • 299-W11-82.	These wells represent data collection points in the vicinity of the waste site. Logging of these wells will provide additional updated site-specific information on contaminant distribution, both laterally and vertically.
216-B-5 Reverse Well		
Radiological data are sufficient to support the RI/FS decision process. Nonradiological data collected through investigation activities at 216-B-7A Crib will be used in the RI/FS process for the reverse well. These sites received the same waste stream. No additional sampling activities are planned at the 216-B-5 reverse well.		

Table 7-4. Key Features of the 200-TW-1 and 200-TW-2 Sampling Design. (5 pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
216-B-7A and 216-B-7B Cribs		
Surface geophysical surveys (GPR and EMI)	Perform GPR and/or EMI over the general area of cribs.	Surface geophysical surveys used to locate crib and subsurface features Geophysics techniques are expected to distinctly identify the crib locations.
Borehole characterization	Install one vadose borehole within the 216-B-7A Crib boundary at the location with the highest contamination potential, avoiding subsurface structures. Location will be based upon interpretation of the surface geophysical results. Borehole will be drilled to the water table. Collect soil samples at 1.5 m, 3.1 m, 4.7 m, 6.4 m, 7.6 m, 9.2 m, 10.7 m, 12.2 m, 15.3 m, 22.9 m, 30.5 m, 45.8 m, and 67.4 m (top of silt layer) (5 ft, 10 ft, 15 ft, 21 ft, 25 ft, 30 ft, 35 ft, 40 ft, 50 ft, 75 ft, 100 ft, 150 ft, and 221 ft) bgs, and at the water table (approximately 76.9 m [252 ft]). Collect bulk density and grain-size distribution samples at major changes in lithology. Collect moisture samples with the other physical property samples.	Install borehole for borehole soil sampling and to support geophysical logging with spectral gamma and moisture tools. Soil samples will be used to determine COC concentrations beneath the crib and in the vadose zone. Sampling provides data for remedial action decision making and will be used to verify the preliminary conceptual contaminant distribution model. Soil physical properties (e.g., moisture content, grain-size distribution, and bulk density) will be used to support modeling.
	Perform spectral logging over the length of the borehole.	SGL will be performed to verify zones of gamma emitting contamination and to refine preliminary conceptual contaminant distribution model.
	Perform neutron moisture logging over the entire length of borehole.	Collect soil moisture data to support numerical modeling efforts.

Table 7-4. Key Features of the 200-TW-1 and 200-TW-2 Sampling Design. (5 pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Borehole spectral logging in existing wells	Perform borehole spectral logging and neutron moisture logging in accessible boreholes and groundwater wells near the cribs. BHI well status records indicate that the following wells are accessible and will provide useful information on contaminant distribution: • 299-E33-58 • 299-E33-59 • 299-E33-60 • 299-E33-75 • 299-E33-20 • 299-E33-19.	These wells represent data collection points in the vicinity of the waste site. Logging of these wells will provide additional updated site-specific information on contaminant distribution, both laterally and vertically.
216-B-38 Trench		
Surface geophysical surveys (GPR and EMI)	Perform GPR and/or EMI over the general area of cribs.	Surface geophysical surveys used to locate crib and subsurface features Geophysics techniques should identify the location of the trench.
Direct push geophysical logging	Install five direct push holes using a direct push method (e.g., Geoprobe); geophysically log holes using spectral gamma and neutron moisture tools.	Logging will be used to verify location of trench, select the location of boreholes, and refine the sampling strategy. Data may also help identify the inlet area of the trench, which is not clear from historical information.
Borehole characterization	Drill at least one deep borehole to groundwater at the discharge point or within the most contaminated/worst case zone in the 216-B-38 Trench. Selection of the borehole location will be based upon interpretation of the geophysical results. Collect soil samples at the bottom of the trench (approximately 3.7 m [12 ft] bgs) at 4.6 m, 6.1 m, 7.6 m, 9.2 m, 12.2 m, 16.8 m, 30.5 m, 45.8 m, and 61 m (15 ft, 20 ft, 25 ft, 30 ft, 40 ft, 55 ft, 100 ft, 150 ft, and 200 ft) bgs, and at the water table (approximately 76.9 m [252 ft]). Collect bulk density and grain-size distribution samples at major changes in lithology. Collect moisture samples with other physical property samples.	Drill borehole for borehole soil sampling and to support geophysical logging with a spectral gamma detector. Soil samples will be used to determine COC concentrations beneath the trench and in the vadose zone. Sampling provides data for remedial action decision making and will be used to verify the preliminary conceptual contaminant distribution model. Soil physical properties (e.g., moisture content, grain-size distribution and lithology) will be used to support modeling.

Table 7-4. Key Features of the 200-TW-1 and 200-TW-2 Sampling Design. (5 pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
	If warranted by the direct-push logging results (i.e., contamination is deeper than the capability of the direct push method), two boreholes may be drilled within the trench at locations between the deep borehole and the direct push locations. Locations will be based upon interpretation of the geophysical results. Total depth will depend on the depth of gamma-emitting radionuclides in the direct-push and drilled boreholes. These two drill casings will be geophysically logged using spectral gamma and neutron moisture tools.	SGL will be performed to effectively locate the areas of high gamma activity to better define the lateral and vertical extent of contaminants within the boundary of the site. SGL will also be used to refine the preliminary conceptual contaminant distribution model.
	Perform SGL for the entire length of the deep borehole.	
	Perform neutron moisture logging for the entire length of the deep borehole.	Collect soil moisture data to expand the database and to support modeling.

7.5 POTENTIAL SAMPLE DESIGN LIMITATIONS

- Drilling impediments (e.g., boulders) may be encountered and/or insufficient sample volumes may be retrieved from the split-spoon samplers. The list of analytes will be prioritized in the SAP to account for insufficient sample volume.

- The 216-B-7A and 216-B-7B Cribs have the potential for cave-in. Safety considerations associated with borehole installation may require additional equipment (e.g., a bridge structure or relocation of the borehole to a safer zone not directly through the crib structure), which may impact sampling location and quality.

- Because the potential exists for significant concentrations of radiological COCs, samples may need to be analyzed in an onsite laboratory. In this case, expected impacts include high analytical costs, degradation of detection limits, reduced analyte lists, and long turnaround times. The presence of transuranics at TRU concentrations would also significantly impact waste handling and management. Sample volumes may be reduced if the radiation levels are high for the samples.

- Geophysical logging of existing boreholes is dependent on accessibility and configuration of the boreholes. If the specified boreholes are not properly configured or available for logging, other boreholes may be considered or the logging program may be reduced.

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